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Engineering Library

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VOL. CXXXIX.—No. 3623] LONDON: FRIDAY EVENING, JUNE 5, 1925 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 19th June, 1925, for LOW-PRESSURE HOT WATER HEATING at Gravesend Post Office and Telephone Exchange.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities, forms for Tender, &c., may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 9369

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 23rd June, 1925, for LOW-PRESSURE HOT WATER HEATING at Attenburg Gardens Telephone Exchange, Battersea.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities, forms for Tender, &c., may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 9370

Chief Draughtsman Re- QUIRED for the PUBLIC WORKS DEPARTMENT of TANGANYIKA TERRITORY for a tour of 20 to 30 months' service. Salary, £450-20-£500 a year, payable in the Territory in local currency, plus a temporary local allowance, up to the 30th June, when it will be subject to review, of 20 per cent. on first £400 of salary and 10 per cent. on the remainder. Outfit allowance of £30 on first appointment. Free quarters and passages. Liberal leave on full salary. Candidates, age 25 to 35, must have had at least 5 years' experience in a responsible position with a good firm of Architects and some practical experience on work, and be capable of preparing plans and taking out quantities for houses and other structural work—Apply at once by letter, stating age, particulars of experience and qualifications, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/13635. 9388

Civil Engineer Required by the GOVERNMENT of UGANDA for the PUBLIC WORKS DEPARTMENT for a tour of 20 to 30 months' service. Salary £400, rising by annual increments of £20 to £500, and thence by annual increments of £25 to £600 a year, plus a temporary allowance of 20 per cent. at present authorised to the 30th June, when the matter of its continuance or otherwise will be considered. Free passages and liberal leave on full salary. Outfit allowance of £30 on first engagement. Candidates, aged 25 to 30, should have served articles with a civil engineer of standing, and be an Associate Member of the Institution of Civil Engineers, or hold equivalent professional qualifications. Should have had, as Assistants, experience of building and road construction, including bridge work, also drainage and water supply if possible. Training and experience in a Municipal Engineer's office would be suitable.—Apply at once by letter, stating age, qualifications, and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/13487. 9390

Civil Engineer Required by the GOLD COAST GOVERNMENT for the Kumasi Public Health Board for a tour of not less than 12 nor more than 18 months' continuous residential service. Salary £480 for the first three years of service, then £510, rising by annual increments of £30 to £720, and thence rising by annual increments of £40 to £920. Outfit allowance £60 on first appointment. Motor cycle allowance £48 a year, payable whilst on duty. Free passages and quarters and liberal leave on full salary. Candidates, aged 25-35, must have received a good technical education and training in the office of a Municipal Borough or City Engineer, have had practical experience in surveying, drainage, town planning, building construction, quantities and estimates. Must be able to ride a motor cycle.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W. 1, quoting M/13,565. 9352

Civil Engineers (2) Re- QUIRED by the GOVERNMENT of the GOLD COAST for the RAILWAY DEPARTMENT. Salary £480 for the first three years of service, then £510, rising by annual increments of £30 to £720, and thence rising by annual increments of £40 to £920, with a seniority allowance of £72 per annum after passing the efficiency bar at £720 per annum. Outfit allowance of £60 on first appointment. Free passages and quarters, liberal leave on full salary. Candidates, aged 25-35, should have served pupilage with a railway engineer or firm of engineers or engineering contractors engaged on railway construction. Must be good draughtsmen and competent in the use of theodolite, level, &c., and have had at least 5 years' practical experience on railway and engineering works.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/13,644. 9351

Civil Engineers (2) Re- QUIRED for the PUBLIC WORKS DEPARTMENT of TANGANYIKA TERRITORY. Salary £500-25-£600 per annum, payable in the Territory in local currency, plus a temporary allowance up to the 30th June, 1925, when it will be subject to review, of 20 per cent. on first £400 of salary and 10 per cent. on the remainder. Outfit allowance of £30 on first appointment. Free quarters and passages. Liberal leave on full salary. Candidates, age 25 to 35, must have been regularly educated as Civil Engineers and be Associate Members of the Institution of Civil Engineers or hold equivalent professional qualifications. Must be capable of levelling, surveying and measuring up work and of preparing neat drawings for the designs of bridges, &c. Must have had at least three years' experience under a qualified Civil Engineer on the construction of harbour works, drainage works, water supply, or other public works.—Apply at once, stating age, qualifications, and experience to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting at the head of application M/13630. 9391

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

German Main Line Electrification.

The British Steam Railway Locomotive from 1825 to 1924—No. 23.

Standardisation of Crane Essentials.

Variable-Speed A.C. Motors.

International Railway Congress.

The Exchange Trials of Locomotives.

A Steam-Extraction Generator Set.

Oil-Driven Pumping Plant at Chipstead.

The Leafield Coupled Arc.

PUBLIC NOTICES

Wanted at Once, Tempor- ARY ENGINEERING ASSISTANTS of good experience in Design of Docks and Heavy Masonry; also one experienced in Design of Reinforced Concrete Wharves; and another accustomed to Steelwork.

Also DRAUGHTSMEN; quick, accurate, with fair general knowledge of Civil Engineering and Building Construction.

Preference given to ex-Service men.

Apply, giving full particulars of experience, age, salary required, when disengaged, and enclosing copy of recent testimonials, to CIVIL ENGINEER-IN-CHIEF, Admiralty, S.W. 1. 9365

Crystal Palace School of Prac- TICAL ENGINEERING.
Founded 1872.
MECHANICAL AND CIVIL ENGINEERING DIVISIONS.
PRESIDENT: J. W. WILSON, M.I.C.E., M.I.M.E.
PRINCIPAL: MAURICE WILSON, M.I.C.E.

Assisted by Staff of Lecturers and Instructors. Thorough, up-to-date Practical and Theoretical Instruction. Course completed in 2 years.

Students admitted at beginning of any term. Of the students who have passed through the School, many have obtained appointments as chief engineers at home and abroad, and upwards of 1400 are employed in engineering work in various countries. 9356

PATENTS AND DESIGNS ACTS, 1907 AND 1919.

Notice is Hereby Given that WILLIAM ALBERT WHITE, late of 601, Washington-street, New York, United States of America, now of the White Engineering Works, Prince Consort-road, Hebburn-on-Tyne, in the County of Durham, a British subject, SEEKS LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 101,947 granted to him for "Improvements in Liquid Fuel Furnaces."

Particulars of the proposed Amendment were set forth in the Illustrated Official Journal (Patents) issued on the 27th May, 1925.

Any person, or persons, may give notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.

W. TEMPLE FRANKS,
Comptroller-General.
9327

Bethnal Green Board of GUARDIANS.
HEATING AND HOT WATER SUPPLY.

The Guardians invite TENDERS for the INSTALLATION of HEATING and HOT WATER APPARATUS at their Institution, Waterloo House, Waterloo-road, Bethnal Green, E. 2.

The plan and specification of the work may be inspected at the undermentioned address any weekday between the hours of 10 a.m. and 12 (noon) and 2 p.m. and 4 p.m. (Saturdays excepted), and a copy of the specification, with forms of Tender, will be supplied upon payment of a deposit of £1, which will be returned on receipt of a bona fide Tender.

Sealed Tenders, in envelopes marked "Heating and Hot Water Supply," must be delivered at my office not later than Twelve Noon on Tuesday, 23rd June, 1925.

The Guardians do not bind themselves to accept the lowest or any Tender.

C. FAULKNER JONES,
Clerk to the Guardians.

Administrative Offices:
Bishops-road, London, E. 2,
3rd June, 1925. 9371

PUBLIC NOTICES

Battersea Borough Council.

The Council invite TENDERS for the SUPPLY and ERECTION of AIR LIFT PLANT to Four existing Artesian Wells at the Public Baths, Latchmere-road.

Full particulars, including specification and form of Tender, may be obtained on application to the Borough Engineer, Town Hall, Lavender-hill, S.W. 11.

Tenders, endorsed "Tender for Air Lift Plant," must be delivered, addressed to the Town Clerk, not later than Twelve o'clock Noon on Saturday, 20th June.

The Council do not bind themselves to accept the lowest or any Tender.

EDWIN AUSTIN,
Town Clerk.

Town Hall, Lavender-hill, S.W. 11,
May, 1925. 9350

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Friday, 26th June, TENDERS for the SUPPLY of:—
GIRDER BRIDGES.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: 91, Petty France,
Westminster, S.W. 1,
3rd June, 1925. 9367

Borough of Torquay. WATERWORKS DEPARTMENT.

The Council of the Borough of Torquay is prepared to receive TENDERS for the CONSTRUCTION of a SERVICE RESERVOIR and ANCILLARY WORKS at Gaze Hill, Highweek, Newton Abbot.

The Reservoir is to be constructed of Mass Concrete with Brick Lining and will have a Reinforced Concrete Roof supported on Brick Piers. The capacity of the Reservoir will be approximately 98,000 gallons.

Specifications and schedules may be obtained on application to the undersigned on payment of a deposit of Two Guineas, which will be returned on receipt of a bona fide Tender.

Sealed Tenders, endorsed "Tender for Service Reservoir, Contract No. 16," together with specification and schedule of prices, must be delivered to the Town Clerk, at his office, Town Hall, Torquay, before Noon on Monday, 15th June, 1925.

The Council does not bind itself to accept the lowest or any Offer.

SAMUEL C. CHAPMAN, M. Inst. C.E.,
Waterworks Engineer.

Town Hall, Torquay,
29th May, 1925. 9326

Great Western Railway.

The Directors of this Company are prepared to receive TENDERS for the PURCHASE of a STEAM PLANT comprising One 810 K.V.A. Turbo Alternator, Two 410 K.V.A. Turbo Alternators complete with Switchboard and Switchgear, Four Lancashire Boilers with Superheaters and Feed Pumps, at their Generating Station, Swansea Harbour.

Forms of Tender and particulars may be obtained on application to the undersigned, by whom Tenders, marked outside "Tender for Plant, Swansea," will be received not later than 10 a.m. on Friday, the 19th proximo.

The Directors do not bind themselves to accept the highest or any Tender.

A. E. BOLTER,
Secy.

Paddington Station, London, W. 2,
26th May, 1925. 9338

PUBLIC NOTICES

City of Nottingham. TO CONTRACTORS.

The Estates Committee are prepared to receive TENDERS from responsible contractors for the CONSTRUCTION of a RIVER WHARF (Steel Sheet Piling and Concrete) on the North Bank of the Trent, adjoining Trent-lane, Sneinton, Nottingham.

Specification, quantities, and form of Tender may be obtained and plans and general conditions of contract may be seen on application to Mr. T. Wallis Gordon, City Engineer and Surveyor, Guildhall, Nottingham, on payment of a deposit of £2, which will be returned on receipt of a bona fide Tender.

Sealed Tenders are to be delivered, in the official envelope provided, to the undersigned, not later than 9 a.m. on Tuesday, the 23rd June, 1925.

The lowest or any Tender will not necessarily be accepted, and Tenders will only be considered from firms having the necessary plant and experience and who conform with the conditions of the contract as regards paying the local standard rate of wages, &c., and with the working rules of the Nottingham district.

By Order,
W. J. BOARD,
Town Clerk.

Guildhall, Nottingham,
29th May, 1925. 9332

The Great Indian Peninsula RAILWAY COMPANY, 48, Copthall-avenue, London, E.C., invite TENDERS for:—

1. MISCELLANEOUS ARTICLES and MATERIALS ..... Fee 10s.
2. LEATHER HIDES, &c. ..... ,, 5s.
3. CARRIAGE DOOR HANDLES, HINGES, &c. ..... ,, 5s.
4. CARRIAGE FITTINGS ..... ,, 7s. 6d.
5. BIB COCKS, &c. ..... ,, 2s. 6d.

Tenders are due by 11 a.m. on 16th June, 1925. Tender forms obtainable at above address. Fees not returnable. 9368

The Madras and Southern MAHRATTA RAILWAY COMPANY, Limited, 25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for:—

24 TONS WHITE LEAD, DRY, and
25 TONS WHITE LEAD, GROUND IN OIL.

Tenders are due in on 16th June, 1925, by 2 p.m. Tender forms obtainable at above address. Fee One Guinea, not returnable.

The Directors do not bind themselves to accept the lowest or any Tender. 9349

Egyptian State Railways, Tele- GRAPHS AND TELEPHONES.

APPLICATIONS for the following APPOINTMENTS are REQUIRED and should be addressed to
THE GENERAL MANAGER,
c/o The Inspecting Engineer (Egyptian Govt.),
Queen Anne's Chambers,
Westminster, S.W.,
not later than June 10th, 1925.

1. ASSISTANT to CHIEF MECHANICAL ENGINEER, at £E1000 per annum, to be in charge of the Drawing-office.
2. DESIGNER, at £E600 per annum, to assist the candidate referred to above in (1).
3. TWO BOILER INSPECTORS, at a salary of £E480 each.

No other remuneration will be paid in addition to the salaries mentioned above.

Appointment will be made on contract for period of two years.

Copy of contract and list of qualifications required from applicant can be obtained from the Inspecting Engineer's Office. 9238

Egyptian State Railways Tele- GRAPHS AND TELEPHONES.

APPLICATIONS for the following APPOINTMENTS are REQUIRED and should be addressed to
THE GENERAL MANAGER,
c/o The Inspecting Engineer,
Egyptian Government,
Queen Anne's Chambers, Westminster, S.W. 1,
not later than June 10th, 1925.

1. ELECTRICAL SIGNAL ENGINEER, at £E600 per annum.
2. ELECTRICAL ENGINEER, at £E360 per annum.
3. ONE DESIGNER, at £E600 per annum, to assist in the Technical Office of Mechanical Dept.
4. ONE MACHINE SHOP FOREMAN, at £E600 per annum.
5. ONE JUNIOR DESIGNER, at £E360 per annum, to work in the same office as No. 3.

No other remuneration will be paid in addition to the salaries mentioned above.

Appointment will be made on contract for period of two years.

Copy of contract and list of qualifications required from applicant can be obtained from the Inspecting Engineer's Office. 9302

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PUBLIC NOTICES

The South Indian Railway Company, Limited.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. HELICAL and VOLUTE SPRINGS.
2. STEEL DRAW-BARS for WAGONS.
3. SPARE PARTS of CARRIAGES and WAGONS.
4. STRUCTURAL STEEL WORKS.
5. STRUCTURAL STEEL WORKS (with Erecting Shop and Coppersmith).

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Springs," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 19th June, 1925.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 5s. for each copy of Specifications Nos. 1 and 2, and of 10s. for each copy of Specifications Nos. 3 and 4, and of £1 for each copy of Specification No. 5.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, of 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France,
Westminster, S.W. 1,
2nd June, 1925. 9266

Aberdeen Water Works.

RESIDENT ENGINEER REQUIRED. Must have large experience of Laying Large Pipes and Concrete Construction. Must be energetic and reliable. Salary at the rate of £450 per annum and motor cycle provided.—Address immediately, stating age, full particulars of experience, references, state of health, and when at liberty, to

GEORGE MITCHELL, M. Inst. C.E.
41½, Union-street, Aberdeen. 9335

SITUATIONS OPEN

9158.—The ADVERTISER THANKS all Those GENTLEMEN who have REPLIED to this ADVT. in issue dated May 15th. He is unable to reply individually. 9345 A

WANTED, MANAGER for Large Slag and Tar-macadam Works, North of England; applicants must have good knowledge of Stone-breakers, Screens and Macadam Plants, and must be capable of handling men.—Address in confidence, stating experience, age, salary required, also send copies of testimonials, 9379, The Engineer Office. 9379 A

WANTED, by Firm of Engineers and Contractors, ASSISTANT ENGINEER with good experience of Rock Tunnelling, Compressor Plant, Rock Drills, &c.; capable of Taking Charge of a section of Tunnels. Only men with actual practical experience need apply.—Address full particulars to 9375, The Engineer Office. 9375 A

CIVIL ENGINEERING ASSISTANT.—WANTED AT ONCE, competent ENGINEERING ASSISTANT; large experience modern Sewerage and Sewage Disposal and Water Supply Works.—Address particulars, 9357, The Engineer Office. 9357 A

CONTINENTAL ENGINEERS REQUIRE JUNIOR ASSISTANT with sound experience in examining, gauging and testing Steel Castings, &c., at works of manufacturers.—Address, 9359, The Engineer Office. 9359 A

INDIA.—FIRST-CLASS MAN REQUIRED as Manager of Railway Wagon Department of important firm; age 28 to 35 years; modern Shop and Drawing-office Experience and ability to control men. Five years' agreement with first-class passage out and home.—Write, giving full details of experience, and copies of testimonials, to "Z.O. 721," c.o. Deacon's Advertising Agency, 11, Fenchurch-avenue, London, E.C. 3. 9384 A

JUNIOR SPECIFICATION CLERK REQUIRED for Motor Engineering Drawing-office.—Address, stating age, experience, and salary required, 9358, The Engineer Office. 9358 A

PATENT AGENT'S ASSISTANT Who is a Registered Patent Agent WANTED. State age, salary required, and experience.—Address, P677, The Engineer Office. P677 A

PRACTICAL MECHANICAL ENGINEER for Factory, N.E. London. Preferably experienced in Matchmaking Machinery or Cigarette Packing or other delicate Machinery. Some knowledge Light Chain Conveying an advantage. Only those giving fullest particulars experience, in confidence, with age, salary, references, considered.—Address, 9333, The Engineer Office. 9333 A

SALES MANAGER REQUIRED IMMEDIATELY by British house for Machine Tool Branch in Belgium. Applications will be considered only from persons speaking French and English fluently, also possessing good knowledge of machine tools. State age, previous experience, and salary required. Applications will be treated confidentially.—Address, 9337, The Engineer Office. 9337 A

STRUCTURAL ENGINEER REQUIRED for British Engineering Works in India, with wide experience in design, estimating, manufacture, and construction of bridge work and all classes of steel structures. Applicants must have had thorough theoretical and practical experience, and be competent to take a senior position. Age 35 to 40.—Apply, stating age, and giving full particulars of qualifications and previous experience.—Address, P698, The Engineer Office. P698 A

QUALIFIED SECRETARY REQUIRED by Responsible Machine Tool Merchants. Applicant must be acquainted with Machine Tools and their value. Progressive position to suitable applicant. State age and salary required.—Address, 9361, The Engineer Office. 9361 A

VACANCY Occurs for a REPRESENTATIVE for Lancashire District with well-known Firm manufacturing Sewage Purification Plant, Penstocks, &c. Preference given to applicants having previous experience and close connexion with surveyors and contractors in the district named.—Address, 9360, The Engineer Office. 9360 A

WANTED by Firm of Engineers and Contractors CIVIL ENGINEERING DRAUGHTSMAN, having good experience in the Design of Hydraulic Work, Bridges and Structural Works; must be particularly well up in the Design of Hydraulic Works as applied to Hydro-electric Works.—Address full particulars to 9376, The Engineer Office. 9376 A

WANTED, DRAUGHTSMAN, by Well-known Firm of Milling Engineers.—Address, stating experience, &c., 9285, The Engineer Office. 9285 A

WANTED, DRAUGHTSMAN, with Good Experience of Hydraulic Work, particularly of Cranes and Hoists. Applications must state experience, salary required and age, which should be between 30 and 40 years.—Address, 9386, The Engineer Office. 9386 A

WANTED, Experienced DRAUGHTSMAN to Take Charge of Drawing-office in important Structural Steel Works; must be capable of Superintending Drawing-office, Designing Steel Structures, checking quantities for estimates and details for shop; splendid opening for capable enthusiastic man. Commencing salary, £400 per annum.—Address, 9380, The Engineer Office. 9380 A

CONSIDERE CONSTRUCTIONS, Limited, Have VACANCIES for TWO ENGINEER DRAUGHTSMEN experienced in Detailing Reinforced Concrete Work.—Apply by letter, 72, Victoria-street, S.W. 1. 9358 A

SITUATIONS OPEN (continued)

DESIGNING DRAUGHTSMAN REQUIRED for Mechanical Handling Plants for Coal and other materials; first-class experience essential.—Address, stating age, full details of experience and salary required, P672, The Engineer Office. P672 A

DRAUGHTSMAN (Constructional) REQUIRED.—Apply, stating age, full particulars of experience, and salary required, to BRAITHWAITE and CO., Engineers, Ltd., West Bromwich. 9354 A

DRAUGHTSMAN.—MANUFACTURERS in East Midlands REQUIRE DRAUGHTSMAN, experienced in Small Two-stroke Marine Engines, preferably of high compression type, and in details of complete installation.—Address, 9329, The Engineer Office. 9329 A

DRAUGHTSMAN, Mechanical, REQUIRED in a Large Engineering Works in East Anglia, with good experience in Steam Boilers and Stationary Steam Engine practice. Must be accurate in detail work.—Address, stating when disengaged, age, salary required, 9339, The Engineer Office. 9339 A

DRAUGHTSMAN, Office and Works Experience in Tanks, Pans, Stills and all kinds of Steel-plate Work, also Cast Iron Work; accustomed to taking out quantities. State age, wages, &c., in strict confidence.—Address, 9377, The Engineer Office. 9377 A

DRAUGHTSMAN REQUIRED, B'ham Area, Accustomed to Stone Breaking and Screening Plant, Elevators and Conveyors, Tar-macadam and Asphalt Machinery. Only applicants with at least 5 years in this work need apply.—Write age, full particulars and salary required to Box P248, c/o 19-21, Corporation-street, Birmingham. P682 A

GOOD DRAUGHTSMAN WANTED for Constructional Engineers' Office in London. Must be thoroughly capable and used to preparing shop drawings from small-scale plans.—Address, stating age, experience, salary required, and when free for engagement, P680, The Engineer Office. P680 A

SENIOR DRAUGHTSMAN DESIGNER WANTED IMMEDIATELY; also JUNIOR. Preference given to applicants with experience of Aero-engine or High-class Automobile Work. Knowledge of High-speed Oil Engines an advantage. Full particulars of experience, age, and salary desired.—Address, "DRAUGHTSMAN," Wm. Porteous and Co., Advertising Agents, Glasgow. P651 A

REQUIRED for a Steel Foundry on the North-East Coast, responsible FOREMAN, to Take Charge of Fettling Shop; must be able to organise and used to up-to-date methods. State salary required, experience and age.—Address, 9351, The Engineer Office. 9351 A

ENGINEERS' PATTERNMAKERS; Permanency for suitable men. District rate.—Apply, P. J. SMITH, 2 and 2a, Wynyatt-street, Goswell-road, E.C. 1. P659 A

SITUATIONS WANTED

MEASURING PUMPS.

ENGINEER. Experienced Installation Design, patents, organisation, services can be SHORTLY AVAILABLE. £800.—P688, The Engineer Office. P688 B

ADVERTISER (26), Keen, Adaptable, Experienced jigs, gauges, machine tool fitting, control of labour, good technical knowledge, at present on works staff, DESIRES CHANGE offering prospects.—Address, P694, The Engineer Office. P694 B

CHARTERED CIVIL ENGINEER SEEKS APPOINTMENT; experience engineers' and contractors' side, and the carrying out of work by direct labour; reinforced concrete, pile driving, roads, bridges, railways, tunnels, caisson sinking, contract plans, parliamentary surveys.—Address, P623, The Engineer Office. P623 B

ENGINEER (42), Good General All-round Mechanical and marine experience, including Diesels, well up in the superintending and consulting branches, 4 years' (residence) German and continental commercial experience, disciplinarian, DESIRES responsible POSITION, home or abroad.—Address, P683, The Engineer Office. P683 B

ENGINEER (31) SEEKS PROGRESSIVE POSITION; works, D.O., construction and administrative exp., turbines, chemical plant, switchgear.—Address, P689, The Engineer Office. P689 B

ENGINEER (32), Shop Production Experience, charge tool design and D.O., planning, practical high-class light manufactures, SEEKS RESPONSIBLE POSITION with scope, preferably London district.—Address, P690, The Engineer Office. P690 B

1ST CLASS B.O.T. CERT. ENGINEER (28), Single, marine, loco., comm., general exp., REQUIRES SHORE APPOINTMENT. Ex. refs.—Address, J., 145, Windsor-road, Penarth. P681 B

MANAGER, Works and General (39), At Liberty, with successful record, REQUIRES POSITION; constructional and general eng., including drop stamp, and mass prod. exp.; ex. refs.; home or abroad; moderate salary.—Address, P642, The Engineer Office. P642 B

YOUNG ELECTRICAL ENGINEER, Englishman, first-class technical and works training in England, DESIRES POSITION with large supply company in England or with firm of consulting engineers undertaking power development overseas. At present with large Canadian hydro-electric and steam utility and dealing with steam and hydraulic power generation and long-distance extra high-tension transmission. Highest references in England and Canada. Present salary £320.—Address further particulars, P662, The Engineer Office. P662 B

WORKS MANAGER (38) DESIRES CHANGE. Specialist in engineering production in general and automobile engineering, estimating, designer of jig tools, &c.; 12 yrs. in executive positions, controlling production to estimates and time.—Address, P693, The Engineer Office. P693 B

DRAUGHTSMAN, First-class, NOW AVAILABLE. Experienced in design and detail work of steam and petrol lorries and light cars.—Address, P691, The Engineer Office. P691 B

LADY TRACER DESIRES SITUATION; Six Years' experience in general drawing-office work. Quick, neat and accurate. Excellent references.—Address, P695, The Engineer Office. P695 B

REQUIRED, SITUATION as TRACER or JUNIOR DRAUGHTSMAN, in General Engineering Works; 4½ years shipyard experience; moderate salary. Any district.—Address, P697, The Engineer Office. P697 B

FOUNDRY FOREMAN SEEKS SITUATION, of wide experience in management of general and repetition work and capable management of men, with good progressive abilities.—Address, P687, The Engineer Office. P687 B

FOUNDRY FOREMAN.—A SITUATION WANTED by a first-class MOULDER and FOUNDRY ORGANISER; used to control of men, mixing and melting of metals, iron and non-ferrous; excellent references.—Address, P692, The Engineer Office. P692 B

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
BUSINESS or WORKS
Write:
WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
London, E.C. 4.
Established over 70 years.

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For continuation of For Sale Advertisements see page 4.

A Seven-Day Journal

The New Naval Programme.

FROM newspaper statements which have appeared during the past few days, it would seem that a definite programme of naval construction has already been approved by the Cabinet, and that it will be presented to Parliament shortly after it reassembles. We understand, however, that such statements are unauthorised and premature. While it is virtually certain that Parliament will be invited to sanction the laying down of certain ships during the current financial year, we have reason to believe that the number and types of these vessels have yet to be finally determined, and that modifications of the tentative Admiralty proposals may be made before the programme is actually laid before the House of Commons, an event that is likely to take place before Parliament adjourns for the summer recess. The framing of a new programme is a task of no small difficulty under present conditions. On the one hand, the need for economy is still pressing, while, on the other hand, there is an urgent need of new ships to replace obsolescent tonnage. We understand that the Admiralty lays special importance on the provision of new cruisers, in view of the remarkable activity in this branch of construction on the part of certain other Powers. At the same time there is a steady shrinkage in our margin of destroyer and submarine strength, and this process must be arrested without further delay if our relative position is not to be forfeited. It is expected that the shipbuilding contracts resulting from the projected programme will all be placed before the end of the calendar year.

A Large Trades Union Alliance.

AT the instigation of the Miners' Federation, a joint conference was arranged to be held yesterday—Thursday—in London between the executives of six of the largest trades unions for the purpose of discussing the formation of an alliance. The unions concerned were those covering the railwaymen, the locomotive engineers and firemen, the transport workers, the engineers, the engineering and shipbuilding trades, and the miners, representing something like two million workers. The former "triple alliance" of the miners, railwaymen and transport workers broke down when put to the test during the great coal trade stoppage in April, 1921. Signs are in evidence that the unions concerned in this new alliance are regarding the proposal with caution, if not suspicion. The watchword of the alliance would be "mutual aid in time of need," but it seems to be felt that the prospects of securing successful co-operation when the moment for it arrived are not too well established. The miners' argument in favour of the formation of the alliance rests upon the assertion that as coal is the basis of the country's industries, distress and difficulty among the miners must automatically involve all other workers. The fact that the railwaymen and the engineering workers, as well as the miners, are at present in the middle of wage negotiations is being used as an additional argument for the combination.

A Notable Towing Feat.

EARLY on the morning of June 1st the reconditioned and enlarged ex-German floating dock, which is now to be used for docking the capital ships of the Mediterranean Fleet, left Sheerness for her station at Malta. The dock was in charge of six naval tugs, the St. Day, St. Mellons, St. Clear, Roysterer, Retort and Resolve, which during the passage down the Medway and through the Thames estuary were further assisted by the Government tugs Firm and Sandboy. As far as Ushant the dock was escorted by the destroyer Thanet, which was later relieved by the destroyer Tomahawk, of the Devonport Reserve Flotilla. When off the Spanish coast the escort duties were taken over by a destroyer from the Mediterranean Fleet. According to particulars which have been made public, the dock as it was originally designed had an overall length of 700ft. and a width of 148ft., with a lifting capacity of about 40,000 tons. Since it was reconditioned at Chatham further sections have been added, increasing its length to about 900ft. and its lifting capacity to 45,000 tons, with about 17,000 tons deadweight. The dock is the largest, we believe, which up to now has been dispatched to a Naval Station abroad, and it is interesting to learn that on this occasion the Admiralty depended entirely upon its own tugs to perform the task.

Motor Ship versus Steamship.

THE economy of the motor ship, as compared with the steamship, has been the subject of a considerable and inconclusive correspondence in the non-technical Press ever since Sir John Biles read his paper on the relative efficiencies of the steam and oil engine for high-speed passenger vessels before the Spring Meetings of the Institution of Naval Architects on April 1st. A summary of that paper and our views upon it will be found in our issue of April 3rd. In this connection, some interesting remarks on the motor ship and its future were made by Lord Kylsant at the annual meeting of the Royal Mail Steam Packet Company last week. In his lordship's opinion, no shipowner who has had experience of the most recent types of steam and internal combustion machinery would question the statement that the steamship is unable to compete in economy of working with a motor ship propelled by the best type of marine oil engine, always provided that the relative price of coal and oil remains constant, and that there is no undue disparity in the capital cost of the two types of ship. With regard to the question of oil supplies, it was pointed out by Lord Kylsant that the amount of oil produced within the British Empire only amounted at present to some 2½ million tons per year. It was necessary for shipowners to purchase their supplies of oil fuel outside the Empire, but he felt that they were in some measure protected as long as the Government held its controlling interest in the Anglo-Persian Oil Company. The other factor which it might be said was delaying the wider adoption of marine oil engines was the high first cost of such engines compared with steam machinery. Lord Kylsant stated that with the example of the inexpensive manufacture of motor car engines by standardised methods before us, he could not help feeling that the application of such methods to marine oil engine manufacture would, to a lesser extent perhaps, make it possible to produce at no distant date a first-class marine oil engine at far lower cost than at present.

The Electrical Engineering Industry.

WHETHER or not the percentage profits being earned by firms engaged in the electrical engineering industry are as satisfactory as they might be, it cannot be denied that in comparison with other branches of engineering the industry is enjoying and has enjoyed for some time past an enviable degree of activity. We refer incidentally in another paragraph to the favourable report made at the general meeting of Henley's Telegraph Works Company. During the past week or so very similar statements have been made at the annual meetings of Siemen's, Callender's, and the British Thomson-Houston Company. That the situation is, however, not entirely satisfactory was emphasised by Mr. D. N. Dunlop, director of the British Electrical and Allied Manufacturers' Association, when submitting evidence last week before the Committee on Industry and Trade. Mr. Dunlop said that the high costs of production had seriously reduced the competitive power of the industry, and that the effects of such reduction had been lessened only by the maintenance of high manufacturing quality and high plant efficiency combined with the "scientific co-ordination of activities." In the ten years following 1913 wages, he remarked, had doubled and taxation had greatly increased the ratio of overhead to total costs. He held the view that a greater national development of electricity was necessary, for not only was the present backward state of the country in the use of electrical energy depriving the electrical industry of an extension of its home markets, but was also crippling other industries that were dependent upon a cheap supply of energy. Mr. L. B. Atkinson, director of the Cable Makers' Association, gave evidence of a similar kind. The production of cables in this country was, he said, about twice as great today as it was in 1914, but competition from abroad had now considerably cut down the margin of profits.

Industrial Efficiency.

SPEAKING on Monday at Welbeck Abbey, the Prime Minister gave it as his opinion that the efficiency of the management of most of our industries could very easily be raised 10 per cent., and that the effect of such an increase on production would be enormous. Indifferent organisation and out-of-date equipment would have to depart, and in their place we must return to that power of swift adjustment to changes which in the past was characteristic of our industrial life. In some instances there can be little doubt that farther improvement of industrial efficiency by action solely on the part of the employer and without the co-operation of labour is impossible, either because of lack of capital or because a very high state of efficiency has already been reached. In others, however, it is equally certain that Mr. Baldwin's contention is well founded. An interesting illustration of what can be done by good management without direct assistance from labour is aptly provided by the account given last Friday of the past fifteen months' business of W. T. Henley's Telegraph Works Company. Speaking at the general meeting, the chairman, Sir George Sutton, stated that the total profits and the sales recorded were the highest in the company's history. That result, he said, had not been derived from an increased production from labour or from lower wages. The production of labour per head in the company's factories improved considerably some five or six years ago, and although it was still satisfactory it had not improved farther. The wages paid for cable making showed an all-round increase over those disbursed in 1923, while rates and taxes amounted to 20 per cent. of the wages bill. Yet employment was 15 to 20 per cent. more than in 1923, and was three or four times as great as in 1914. The company's favourable position, Sir George said, was to be ascribed entirely to wise management. By conserving liquid resources, by accumulating reserves and by limiting dividends, the management had been enabled to develop enterprise and extend the company's activities, and so secure an increased turnover year by year.

The William Froude National Tank.

FROM the annual report issued last week of the Advisory Committee for the William Froude National Tank, we learn that during 1924 the demand for tests of both ships and propellers steadily increased. During the year 62 hull models were tested for firms, as compared with 56 and 35 in 1923 and 1922 respectively. This increase of private test work is, in the Committee's opinion, probably to be accounted for by the pressing need for propulsive economy in the running of ships in these almost profitless times. The greater number of the designs tested were for oil engined vessels. Sixteen of the models were altered in shape at the Tank, with the result that there was an average reduction of 6 per cent. in the power required for propulsion, while in one case the reduction effected was as much as 16 per cent. With coal at 25s. per ton, it is estimated that if one ship only is built to each model, the total saving per annum represented by the reduction of power obtained by the alterations in the model forms would amount to some £10,500, or sufficient to cover the expenses of the Tank for some years to come. It is noted that the pressure of private test work interfered with the conduct of research investigations, but that even so increased support is required for the Research Fund if the work at the Tank of a fundamental kind is to be continued. There is some talk of constructing another tank at Teddington on lines somewhat different from those of the tank so generously provided by Sir Alfred Yarrow. With such an addition, delays which now occur in obtaining test results for firms would be avoided. We gather that the new tank would be of a high-speed type, and would be particularly suited for testing seaplane models.

Association of Teachers in Technical Institutions.

IN his presidential address before the Association of Teachers in Technical Institutions, delivered in Birmingham on Monday last, Mr. W. E. Harrison said that in view of the development of technical education during the past forty years, and the doubts and misunderstanding shown as to its meaning and function, the Association had long been of opinion that there should be an inquiry into the relationship of technical education to other forms of education and to industry. The Association felt that such an inquiry would do much to prevent overlapping and waste, and lead to a wider system of education, with a clearer conception of the goal towards which the nation must proceed if it was to make progress. Year after year the Association had passed resolutions asking for that inquiry, but the Board of Education, although sympathetic, had not yet seen its way clear to take up the matter. After careful consideration the Association had decided that it would have to undertake at least a preliminary investigation itself. A small committee was set up by the Association of Teachers in Technical Institutions, the Association of Principals of Technical Institutions, the Association of Technical Institutions, the National Society of Art Masters, and the Association of Education in Industry and Commerce. The committee communicated with the national bodies which would be interested with gratifying results, and on February 27th a conference took place under the chairmanship of Lord Emmott. Since the meeting the bodies concerned had nominated their representatives on the committee of inquiry, and it was hoped that the work would soon begin in several typical areas.

Commercial Airships.

WHEN he was asked last week in the House of Commons whether the flights of the reconditioned airship R 33 had enabled the Air Ministry to form an opinion as to the trustworthiness and safety of airships for commercial service, Sir Samuel Hoare replied that he thought that, even on the limited experience obtained up to the present, the anticipations in this respect had been justified. The trustworthiness of commercial airship services could not, however, he explained, be established by the flights of any particular ship, but would require a comprehensive programme of experiment and research, including trials on a commercial route. In this connection it may be noted that during the past week the Italian authorities have succeeded in contributing something towards the desired experience of the possibilities of commercial airships. In a little over twenty-five hours' actual flying time two Italian airships flew from Rome to Barcelona and thence to Toulon and back to Rome. The total distance covered was about 1500 miles, so that the average speed was in the neighbourhood of 60 miles an hour. The journey was performed at a height of from 1200ft. to 1500ft., and although some stiff winds were encountered, was completed entirely without untoward incident. The commander of the expedition has expressed a confident belief in the possibility of running on the route followed an all-year-round once or twice weekly commercial service.

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. XXIII.*

PERIOD 1866 TO 1869.

Express Engines with Single Driving Wheels.—Before the year 1866 had come to an end, most of the leading railways had discontinued the construction of "single" engines, at least for a considerable period. This does not imply by any means that those already built were relegated to secondary services, since for many years to come the majority of express trains were worked by them. There were two railways, the Great Northern and the Great Western, the locomotive superintendents of which differed from their colleagues on other lines, and held stoutly to the single engine.

Joseph Armstrong's G.W.R. standard gauge express engines, built at Swindon 1866–1869, are illustrated by Fig. 174. They had 17in. by 24in. cylinders, driving wheels 7ft., and carrying wheels 4ft. diameter, wheel base 7ft. 8in. + 8ft. 4in. = 16ft. An excellent feature of Great Western practice was the ample boiler power provided. The barrel was 11ft. long by 4ft. 2in. diameter, and the total heating surface 1268.9 square feet, of which the fire-box supplied 98 square feet; grate area, 16¾ square feet. The original weight was 29 tons 4 cwt., of which 12 tons 8 cwt. rested on the drivers. Subsequently this weight proved insufficient, and modifications were made which increased the total weight to 31¼ tons, of which 14 tons were available for adhesion. An unusual metamorphosis of these engines took place when 21 of the total of 30 were converted by W. Dean in 1900–1902 to 0–6–0 goods engines, the old frames and motion being retained.

In 1866 A. Sturrock on the G.N.R. fell into line with other locomotive engineers, and designed six large 2–4–0 express engines, which were built by John Fowler and Co., of Leeds, and the Yorkshire Engine Company, of Sheffield. They had double

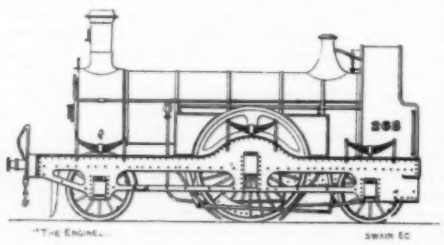


FIG. 176—STURROCK'S ENGINE—RE-BUILT

frames, the outside members being of the sandwich type. The engines were illustrated in THE ENGINEER of August 18th, 1922, page 160. The cylinders were 17in. by 24in., driving coupled wheels 7ft. diameter. The leading wheels were placed underneath the smoke-box, with the result that the remarkably long wheel base of 9ft. 7in. + 8ft. 6in. = 18ft. 1in. was obtained. The axles and tires were of steel, and the outside coupling rod cranks had the long throw of 14in. In this respect Sturrock seems to have followed E. B. Wilson's practice. The engines were not very successful on the fastest express trains, and between 1873 and 1878 P. Stirling rebuilt all of them as 2–2–2 single engines—as shown in Fig. 176. The reasons for this alteration will be mentioned subsequently; suffice it to say here that the coupled express engine was far from showing superiority over the "single" at that time.

As soon as P. Stirling took charge in 1866 of the locomotive department of the G.N.R., he determined to adhere to single engines, just as he had done on the Glasgow and South-Western Railway. His first express engines, of which 13 were built at Doncaster, 1868 to 1870—see THE ENGINEER, November 28th, 1913, Supplement—differed completely from his outside cylinder inside framed designs for the Scottish railway. The G.N.R. engines were of an enlarged and much improved "Jenny Lind" type, with inside cylinders, inside bearings for the driving wheels only, and outside bearings for the carrying wheels. Stirling at once adopted Sturrock's long wheel base with leading axle under the centre line of the smoke-box. The domeless boiler with perforated steam pipe, and the plain but efficient G. and S.W. cab with circular side windows also appeared. The cylinders were originally 17in. by 24in.; but some years later were enlarged to 17½in. diameter. The driving wheels of 12 engines were 7ft. 1in. diameter, but the thirteenth—No. 92—had 7ft. 7in. drivers, the wheel centres having been taken from Sturrock's large bogie engine, which was broken up in 1870. The wheel base of the first twelve was 9ft. 6in. + 7ft. 6in. = 17ft., increased in the case of No. 92 to 9ft. 9in. + 7ft. 9in. = 17ft. 6in. The boiler, the centre of which was pitched 7ft. 2in. above rail level—7ft. 4in. in the case of No. 92—had a total heating surface of only 1011¾ square feet, of which the fire-box provided 89½ square feet; grate area, 16.4 square feet; pressure, originally 130 lb.; weight on drivers, 14 tons; total weight in working order 33 tons. The hornblocks were of cast steel.

The heating surface of Stirling's engines was always comparatively small, but he rightly preferred plenty of space between the tubes, which in the above engines were 192 in number and 1¾in. diameter. In one of them the tubes were reduced to $1^{9}/_{16}$in. diameter without affecting the efficiency of the boiler from the running point of view. The fire-box roofs were stayed by girders.

Four-coupled Express and Passenger Engines.—P. Stirling also designed the 2–4–0 engine—see THE ENGINEER, November 28th, 1913. Twenty of the type were built by the Avonside Engine Company and the Yorkshire Engine Company in 1867–8, and therefore preceded the single engines described above. As built, the cylinders were 17in. by 24in., enlarged subsequently to 17½in. diameter. Diameter of driving wheels, 6ft. 7in.; and of leading wheels, 4ft. 1in.; wheel base, 9ft. 6in. + 8ft. 3in. = 17ft. 9in.; total heating surface, 1085½ square feet. The leading plate springs were placed below the platform behind the framing, an inaccessible position in case of breakage. Nevertheless this practice was continued throughout Mr. Stirling's superintendency, and it was not until Mr. Ivatt's time that all Stirling's engines were altered and the springs removed to the usual position above the platform.

From 1874 onwards the cylinders of the later engines were 17½in. by 26in., but in most respects the type remained the same until 1895, the principal changes being that the pressure was increased about 1888 to 160 lb., and the wheel base between leading and driving wheels lengthened to 9ft. 8in. On the other hand, as time went on the tube heating surface, as in the case of nearly all Stirling's engines, was reduced, though that of the fire-boxes remained practically the same. The total heating surface of the later engines was only 929.3 square feet in spite of the larger cylinders.

The first twenty engines of 1867–8 were probably intended for express trains, but if so, they were soon relegated to service with secondary trains, and to the end of Stirling's life the single engine remained supreme for Great Northern express work. It is a noteworthy fact that though Stirling's "singles" of all classes did wonderful work, the coupled engines, though very good for semi-fast and stopping trains, were much inferior on the expresses. The reason probably lay in the fact that the celebrated old engineer went somewhat too far in reducing his boiler power.

The 2–4–0 express engines of the L. and N.W.R.—Fig. 175—were built at Crewe 1866–1873, to J. Ramsbottom's designs, and were primarily intended for the express services between Crewe and Carlisle, and Crewe and Holyhead. They must not be confused with F. W. Webb's later "Precedent" class, which, though of similar general dimensions and mainly derivatives of them, differed in several material respects. There were 96 of the "Ramsbottoms," of which the illustration shows one of the last twenty, which were provided with cabs, instead of the small weatherboards of the earlier engines. All were fitted with Stephenson's link motion. The frames and all bearings were inside in accordance with the invariable practice of the L and N.W.R. The cylinders were 17in. by 24in. (though in a few of the earlier engines they were stated to have been 16in. diameter originally); driving wheels, 6ft. 7½in.; leading wheels, 3ft. 7½in.; wheel base, 7ft. 5in. + 8ft. 3in. = 15ft. 8in. The boiler, the centre of which was 6ft. 11in. from rails, contained 192 1¾in. tubes, of which the heating surface was 1013 square feet; total heating surface, 1102 square feet; grate, 14.95 square feet. Weight in working order of the earlier engines:—Leading, 9 tons 8 cwt.; driving, 10 tons 10 cwt.; trailing, 8 tons 15 cwt.; total, 28 tons 13 cwt. The pressure was 120 lb., a figure somewhat low for the period when the engines were built.

The earlier engines of 1866–1871 were provided with Ramsbottom's usual air inlets, consisting of two circular holes, 7in. diameter, in the front of the fire-box under the brick arch, and covered by doors worked from the footplate to regulate the air entry. These holes were abandoned by F. W. Webb, as they caused trouble with the fire-box plates. Although steel boilers had been tried previously, these engines had boilers of Low Moor iron $^{13}/_{32}$in. thick.

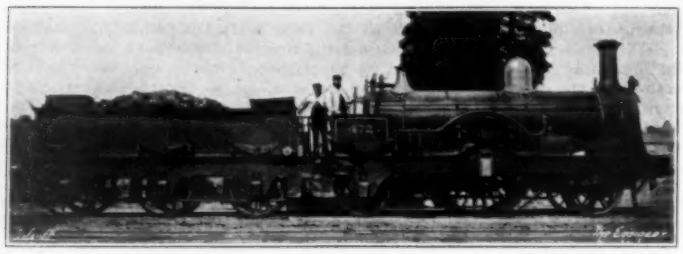


FIG. 174—ARMSTRONG'S EXPRESS LOCOMOTIVE, 1866-69

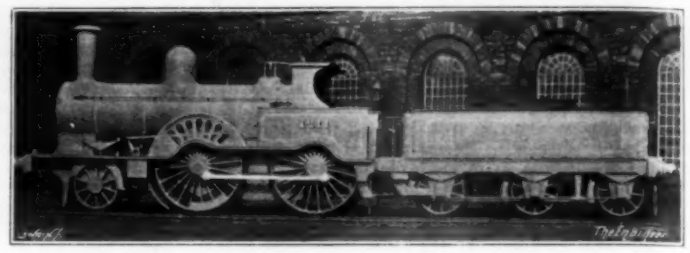


FIG. 175—RAMSBOTTOM'S ENGINE, 1866-73

For the Derby–Manchester section and also in anticipation of the opening in 1868 of the main line extension from Bedford to St. Pancras, for the traffic on which the existing single engines were not suitable in view of the gradients, the Midland Railway placed in service a type of 2–4–0 fast passenger engine, of which there were two distinct designs, though the general dimensions were similar. Both classes had 16½in. by 22in. cylinders, 4ft. 2in. leading and 6ft. 2½in. coupled wheels, with a wheel base of 8ft. + 8ft. 6in. = 16ft. 6in. Like all Midland passenger engines built before 1870, the boilers, which carried 140 lb. pressure, had raised fire-box casings. But the details of the motion and outside framing were entirely different, and as they represent typical designs, both are illustrated. The engines—Fig. 177—were designed and built at Derby in 1866–1868. The outside plate frames were of the slotted out type, the ties between the horns being solid with the plates. The cylinders were horizontal, and the valve spindles were supported by the usual Midland type of guides bolted by means of flanges to the upper slide bars, of which there were four. These engines, which have done excellent service, seem to bear a charmed life, chiefly on account of the strength and solid design of the original frames. They were rebuilt by S. W. Johnson in 1895–9, with 18in. by 24in. cylinders,

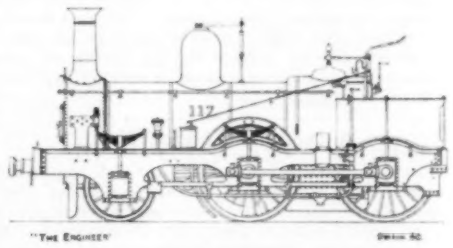


FIG. 177—MIDLAND ENGINE, 1866-68

and nearly twenty of them are still at work, under London, Midland and Scottish Nos. 1 to 22.

Of the other class—Fig. 178—thirty were built by Beyer, Peacock and Co. in 1867, and were typical of this firm's double plate framed engine. The frames were not so deep as those of the Derby-built engines, and were without tie connections between the horns. The platforms were lower. The tires were of Krupp steel. The valve spindles were suspended by swing links from brackets attached to the motion plate. These engines also did good service for a period of thirty to thirty-five years, but the writer understands that the design was not so adaptable for the larger 18in. by 24in. cylinders, which were later required, and they were broken up.

The original boilers of the above engines were 11ft. long by 3ft. 11in. diameter inside the front ring, and contained 168 2in. tubes. The total heating surface was 1071½ square feet, of which the fire-box supplied 80.1 square feet; grate area, 14.8 square feet; the average weight was 33¼ tons.

As now running, the Derby-built engines—L.M.S., Nos. 1 to 22—with 18in. by 24in. cylinders, have a total heating surface of 1079½ square feet, with larger fire-box, and weigh 41¼ tons in working order.

The excellent little passenger engines—Fig. 179—were amongst the earliest of S. W. Johnson's design. They were built for the G.E.R., 1867–1872, during his locomotive superintendence of that railway, thirty by Sharp, Stewart and Co., and ten at Stratford works, and were derived from a class for which

* No. XXII. appeared May 29th.

he was responsible when on the North British Railway. The latter had larger 6ft. wheels and domeless boilers. The cylinders of the G.E.R. engines were 16in. by 22in.; diameter of coupled wheels, 5ft. 7in.; wheel base, 14ft.; total heating surface, 772¾ square feet; weight of engine in working order, 29 tons 2¾ cwt.; all work" on the G.N.R., must not be omitted. This type—Fig. 181—was the first designed and built by Stirling for the G.N.R. at Doncaster in 1867, from which year until 1895, no less than 154 were placed in service, with only slight variations in detail between the first and the last. They worked most of the

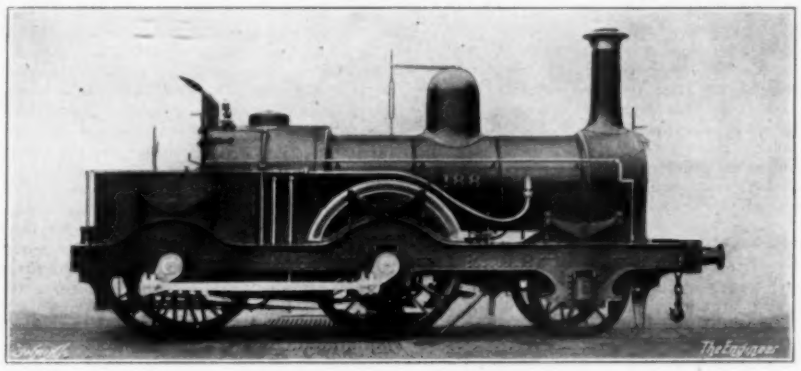


FIG. 178—MIDLAND ENGINE, 1867—BEYER PEACOCK

pressure, 140 lb. For a period of thirty-five to forty-seven years they worked principally over the long cross-country lines of the Great Eastern.

Of 2–4–0 express engines with outside cylinders, the majority were to be found on the London and South-Western and Caledonian railways. Joseph Beattie's engines on the former line were generally similar to those already described—Fig. 115 *ante*. All had 17in. by 22in. cylinders and 130 lb. pressure, and, with the exception of thirteen with 7ft. wheels, had 6ft. 6in. coupled wheels.

For the express and fast trains on the northern sections of the Caledonian Railway, and also between Greenock, Glasgow and Edinburgh, the type of coupled engine—Fig. 180—was designed by B. Connor. As on the L. and S.W.R., there were two classes, with 7ft. 2in. and 6ft. 8in. coupled wheels, of which the former, built in 1867–8 by Neilson and Co. and at St. Rollox works, had the largest coupled wheels in the country. The old Crewe type of mixed framing was retained. The cylinders of both classes were 17in. by 24in., and the wheel base 7ft. 1½ + 8ft. 7in. = 15ft. 8½in. The boilers were small, as regards total heating surface, which varied in different classes. In the engines—Fig. 180—by Neilson and Co., 1868, there were 150 2in. tubes in a barrel 4ft. 2in. diameter outside; tube heating surface, 834 square feet; fire-box, 86 square feet; total, 920 square feet; pressure, 140 lb.; grate area, 14.4 square feet. The total weight in working order of the earlier engines was 33 tons. This type of engine was

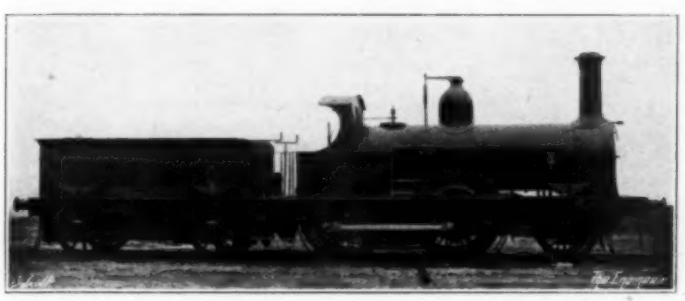


FIG. 179—S. W. JOHNSON'S ENGINE, 1867

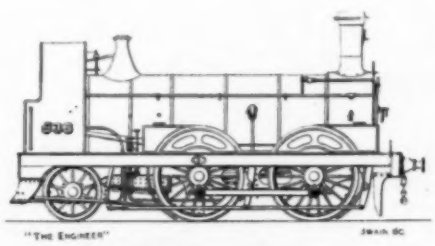


FIG. 181—GREAT NORTHERN ENGINE, 1867

boilers, but the heating surface was always small, ranging from 1075 square feet in the earlier to 837½ square feet in later engines. The heating surface given by P. Stirling to his boilers had a way of becoming "small by degrees and beautifully less" as the years passed by, not only in the case of these, but also of his express engines. The pressure was 140 lb. The wheel base was 7ft. 3in. + 7ft. 11in. = 15ft. 2in. until 1882, when the distance between driving and trailing centres was increased to 8ft. The average wheels, 5ft. 7½in. diameter; trailing wheels, 3ft. 7½in. diameter; but in the last thirty-three engines, from 1882 onwards, the diameter of the latter was increased to 4ft. 1½in. There was some variation in the weight in working order was about 32½ tons, of which nearly 26 tons were available for adhesion.

If one might be allowed to criticise engines which had a long career of usefulness, it would be from the standpoint of insufficient grate area. When working even moderately hard, they threw out a large amount of cinders and unburnt fuel, the result of forcing the small boiler and grate with a small blast pipe. All these engines have now disappeared. H. A. Ivatt rebuilt about ten of them with larger domed boilers in 1902, but discontinued the experiment shortly afterwards. A number of similar engines were designed by James Stirling and built by Neilson and Dübs for the Glasgow and South-Western Railway.

Four-coupled Passenger Tank Engines.—The first 0–4–4 tank engines with front coupled wheels and trailing bogies—Fig. 182—were built by Brassey and Co., of the Canada Works, Birkenhead, for the S.E.R. to J. I. Cudworth's designs. They were derived from some similar 0–4–2 tank engines of 1863–4, and to increase the coal and water space a bogie was substituted for the single trailing axle. The axle-box pillars of the coupled wheels were connected by long compensating beams with single spring between, a revival of Cudworth's 1853–5 practice—Fig. 91 *ante*. The bogie, which had a 6ft. wheel base, was of the outside framed pattern, with similar compensating beams, and brake blocks actuated by hand were applied to its wheels. The cylinders were 15in. by 20in.; coupled wheels, 5ft. 7in. diameter; bogie wheels, 3ft. 8in. diameter; wheel base, 7ft. 3in. + 7ft. 3in. + 6ft. = 20ft. 6in.; total heating surface 903 square feet; and pressure, 130 lb. The weight of the locomotive in working order, was 33 tons 14 cwt., of which the bogie carried 11 tons 12½ cwt.

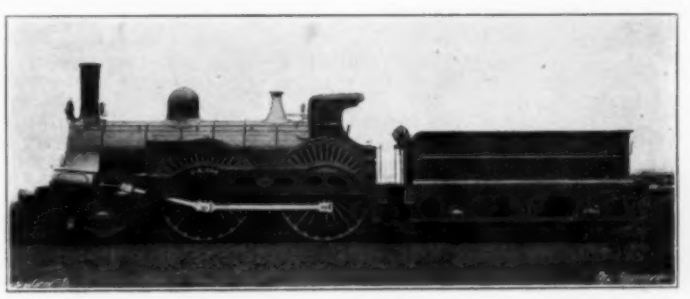


FIG. 180—CALEDONIAN ENGINE, 1868

A very similar engine was built by J. C. Craven at Brighton works later in 1866. It had 5ft. coupled wheels, 16in. by 20in. cylinders, and the coupled wheels had independent springs.

The celebrated outside cylinder 4–4–0 side-tank engines designed for the North London Railway, by W. Adams and built at Bow Works, are illustrated in Fig. 183. The first of these engines came out in July, 1868, since when they have remained the standard type on that railway, with minor modifications which left the principal features of the design untouched. In many respects they were a bold departure. The bogie was of the Adams sliding type, first used in 1865 and having a lateral movement of 2in. each side. But the drawings of these and other early Adams bogies on the Great North of Scotland Railway show no check springs, which were evidently a later addition. In fact, it was stated that the lower part of the sliding block was made a moderately tight fit between the angle iron slides, so that lateral movement should not take place too readily, or, in other words, the deviating force was opposed by frictional resistance. But very shortly afterwards india-rubber check springs were added. Between the upper portion of the pivot block, which was widened into a ring, and the plate sliding on the bearing a thick rubber ring was interposed. Although nearly all locomotive engineers, including Adams himself in later designs, dispensed with the india-rubber ring, and also used spiral or plate check springs for controlling the lateral movement, the

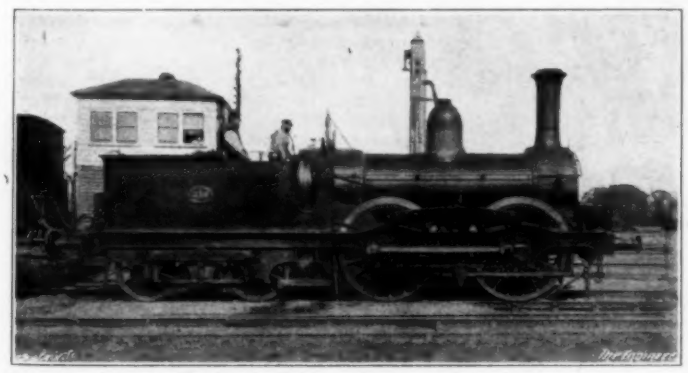


FIG. 182—SOUTH-EASTERN TANK ENGINE, 1868

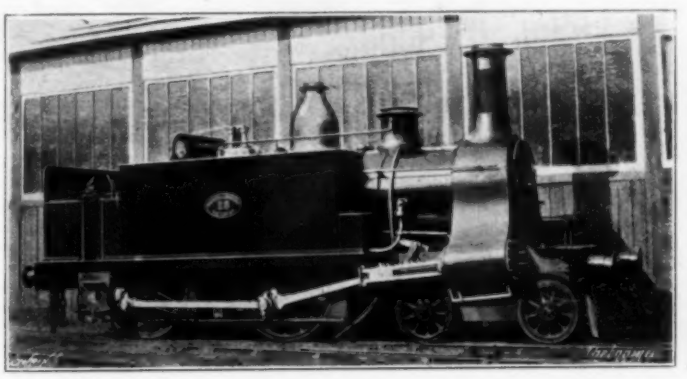


FIG. 183—NORTH LONDON TANK ENGINE, 1868

built until 1874, the last series by Dübs and Co. having 17½in. cylinders. A detail of Caledonian practice was the use of double coned journals.

Four-coupled Mixed Traffic Engines.—Although presenting no special features beyond extreme simplicity, P. Stirling's 0–4–2 engines, the "maids of

rubber ring and check springs are still in use on the North London and Great Eastern bogies.

The cylinders were secured by passing the steam chests through the frames, and to keep them from working loose each steam chest was made with longitudinal planed projections which fitted into grooves in the transverse castings uniting the frames. The horn cheeks of the driving and coupled axle-boxes were of steel, and the horn blocks were of the horseshoe pattern now almost universal. The boiler pressure was 160 lb., the highest at that time in this country. The leading dimensions were :—Cylinders, 17in. by 24in.; coupled wheels, 5ft. 5in.; bogie wheels,

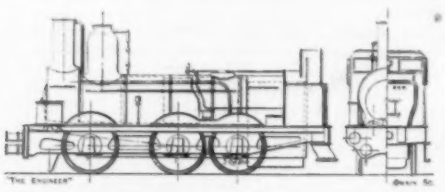


FIG. 184—STOCKTON AND DARLINGTON ENGINE, 1866

4ft. 9in. diameter; wheel base of bogie, 5ft. 8in.; coupled wheel base, 8ft.; heating surface, 1015 square feet; weight in working order, 43 tons 12 cwt., of which the bogie carried 14 tons 14¼ cwt. Of the total weight, 38 tons 12 cwt. empty, the amount on the bogie was 15 tons 14 cwt., about 1 ton more than when the engine was loaded, owing to the weight of the water and coal being chiefly behind the driving wheels.

Six Wheels Coupled Tender Engines.—The only 0–6–0 engines which need be mentioned were of W. Bouch's Stockton and Darlington "long boiler" type, which from 1866 to 1874 was with slight varia-

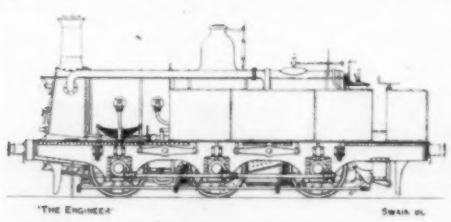


FIG. 185—METROPOLITAN TANK ENGINE, 1868

tions standard on that line. They were built at the North Road Engine Works of the company at Darlington and by Hawthorn, Stephenson, Hopkins Gilkes and Co., of Middlesbrough, and other makers. The diagram Fig. 184 shows these engines. Bouch always preferred the "long boiler" engine, for the reason that a larger water area was available. The shape of the inside plate frames is clearly shown in the diagram. A very unusual feature was the fire-box, which had a flat top stayed by direct iron stays to a flat outside casing plate in a very similar manner to the Belpaire fire-box, but differed from the latter in that the top of the outside wrapper plate was lower than the top of the boiler barrel. By the use of direct stays the weight on the trailing wheels was reduced by about ¾ ton. The fire-box had a longitudinal mid-feather below the level of the fire-door. The feed-water heater was of Bouch's design, in which the cold feed was led into an annular space round the chimney, where it was heated by exhaust steam which passed through a coil. The exhaust was taken to the chimney by means of a pipe led from the exhaust space just below the base of the blast pipe.

The cylinders of all Bouch's S. and D. engines were 17in. diameter, but the stroke varied from 24in. upwards. The majority had 26in. stroke, but five engines built by Hawthorn in 1870 had 28in. stroke. The wheels had a diameter of 5ft. and, unlike those of many long boiler engines, the driving tires had flanges. Wheel base, 7ft. 9in. + 5ft. 3in. The boiler barrels varied from 14ft. to 14ft. 6in. in length by 4ft. diameter, and the heating surface attained 1300 square feet in the largest of the type. The weight of the latter in working order was 37½ tons.

Six Wheels Coupled Tank Engines.—These were chiefly used for special service on lines with severe gradients, and there were very few engines specially designed for shunting work. The Great Western in 1864 led the way with 0–6–0 saddle-tank engines for local goods traffic, and a few similar engines were built at Doncaster by P. Stirling.

Of the three types which merit special mention, the first—Fig. 185—was specially designed by R. H. Burnett for the passenger traffic on the St. John's Wood section of the Metropolitan Railway, and was built by the Worcester Engine Company in 1868. The gradients, varying from 1 in 27 to 1 in 80, are very severe, and the line rises 235ft. in 2¾ miles. The principal consideration which affected the design was that the normal steam pressure of 130 lb. was liable to fall rapidly owing to the necessity for continuous condensing in the tunnel, with the consequent absence of blast, and therefore great cylinder power was necessary as a reserve. The cylinders, 20in. by 24in., the largest of that day, were inclined at 1 in 8½. The valves were on the top and were actuated by rocking shafts and Allan's straight link motion. The springs of all three axles were connected by compensating levers, which were placed outside the outer frames, for the reason that they were intended to be removed if found unnecessary in service. They were dispensed with subsequently, but whether that was done before the engines were sold is uncertain. The driving and trailing springs were placed in recesses behind the tanks. The wheels were 4ft. in diameter; the wheel base was 14ft. and the leading and trailing axles had lateral play; heating surface, 1132 square feet; grate area, 22½ square feet; weight (full), 45 tons. These engines were too large for the work and less economical than the standard 4–4–0 tank engines, and when Joseph Tomlinson became locomotive superintendent they were laid aside, and afterwards sold to the Taff Vale and Sirhowy Railways, on which the cylinders were lined up to 17½in. and 18in. diameter. Sectional drawings were published in THE ENGINEER, October 4th, 1895.

For the Brecon and Merthyr main line, which has very long banks of 1 in 38 to 1 in 40, the engines illustrated in Fig. 186 were designed and built by Sharp, Stewart and Co., 1866–1868. These were considered extremely powerful engines at that time, and their duty was to take ten loaded wagons and two vans—100 tons—at the regulation speed of 8 miles per hour up the Talybont bank of 1 in 38 for about 6¾ miles. They were saddle-tank engines of the Stephenson long boiler type, the wheel base being 12ft. The cylinders were 17in. by 24in.; coupled wheels, 4ft. 6in.; the boiler barrel was 4ft. 1¾in. diameter outside and contained 148 2in. tubes, 13ft. 9in. long; tank capacity, 1100 gallons; weight loaded, 38 tons.

Some banking engines for the Furness Railway, built 1868–1873 by Sharp, Stewart and Co., to their own designs, had very long side tanks, cut away to provide access to the motion. The cylinders were 18in. by 24in.; wheels, 4ft. 6in. diameter; total heating surface, 1144 square feet; grate, 15 square feet, pressure, 145 lb.; weight loaded, 41¾ tons. The iron frames were 1¼in. thick and the

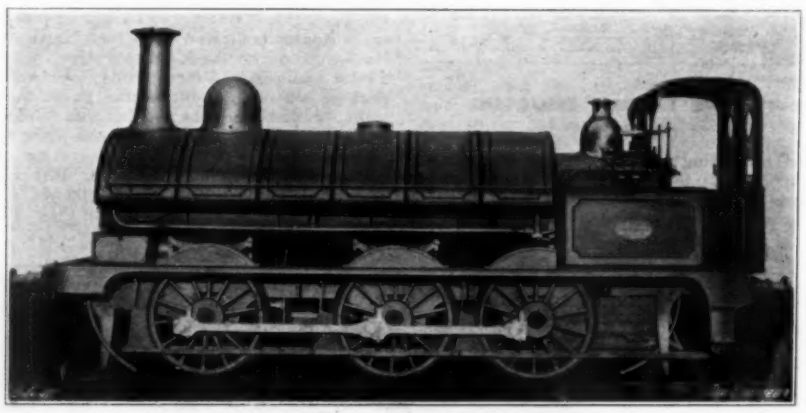


FIG. 186—SHARP, STEWART AND CO.'S TANK ENGINE, 1866-8

Yorkshire iron boiler plates ½in. thick. The crank axles were of Bessemer steel.

Six-coupled Passenger Tank Engines.—In 1868 the North British Railway followed the lead of the Lancashire and Yorkshire in the use of 0–6–0 saddle-tank engines for local passenger services, and a considerable number were built at Cowlairs from 1868 to 1873. It is unnecessary to illustrate these engines, which presented no features of special interest. The saddle tanks extended from the back of the smoke-box to the back of the fire-box casing. The cylinders were mostly 16in. by 24in.—though a few had 22in. stroke—and the coupled wheels, which had inside bearings only, were 5ft. in diameter. Pressure 130 lb.; weight in working order, about 36½ tons. These engines were designed by Mr. Wheatley, then locomotive superintendent.

The Standardisation of Crane Essentials.

By EDWARD G. FIEGEHEN, M.I. Mech. E.

THE last quarter of a century has seen a phenomenal development in crane construction and application. This development is due in a great measure to the great adaptability of the modern electric motor, which has freed the designer in his task of fitting the crane to its job from many of the limitations imposed by the employment of other sources of power. Ample scope for versatility in design is always desirable, but if progress is to be real and not illusory, development must proceed on sound lines, so that any new type may have real merit, as well as the attraction of novelty, to recommend it to the user.

In many branches of engineering sound progress has been facilitated and directed by the collation, classification and publication of the successful experience of the past, periodically brought up to date by specialists and published in the form of standard specifications. In this country the series of British standard specifications is a good example, and these are available for use and are used in crane design so far as they apply. Many essential matters in connection with crane design, however, are still outside such specifications, although they are quite capable of co-ordination in a satisfactory and helpful manner.

Briefly stated, the advantages to be secured by standardisation are :—

(1) Brevity and economy in the preparation of inquiries and tenders without sacrificing precision or completeness.

(2) Economy in manufacture, owing to uniformity of requirements.

(3) Larger stocks of components can be profitably held; hence quicker delivery can be made of new machines, and a better spare-part service can be organised.

(4) Common basis of quality, resulting in more uniform tendering and more accurate costing.

(5) Simplification of the work of the staff, as there is only one specification to learn.

In the compilation of an acceptable standard, the best efforts of makers and users will be needed, for many existing departmental specifications contain useful clauses that might be adopted, wholly or in part. The present lack of uniformity causes great confusion and loss. At one extremity we have the consultant's elaborate specification, and at the other the vague and sketchy inquiry from the busy merchant—both very unsatisfactory.

Many good orders have resulted from inquiries that made their first appearance as mutilated cablegrams, but the result has generally been due to the efforts, aided possibly by the reputation, of the successful manufacturer, in spite of the lack of greater facilities.

It is in connection with overseas trade that a standard specification, suitably coded, should prove of inestimable service, both as a standard of value and as a means of communication, and with regard to the latter, it would have the beneficial effect of putting British makers on a more level footing with competitors who are within easier postal reach of the customer. The compilation of a standard specification may be considered under the following headings :

(1) Working load; test load.
(2) Provision for impact and secondary loading.
(3) Operating speeds, acceleration, &c.
(4) Safety provisions; stability.
(5) Working stresses; deflections; basis of calculation.
(6) Grades of workmanship.
(7) Testing.
(8) Nomenclature; definitions.

It may here be permissible to make a few observations to indicate the probable scope of classification under the above headings.

(1) *Loads.*—The maximum working load upon a crane will necessarily form the basis for all strength and stability calculations. The test load to be applied on completion should exceed it by some agreed percentage that will be sufficient to reveal any weakness of construction or performance without inflicting permanent damage upon a properly designed and constructed machine. It is desirable that cranes should be re-tested at intervals during their useful life, and after each re-erection. We have comparable practice in the testing of bridges, boilers, motors, &c., and the ratio of test load to maximum working load has in each instance received most careful consideration.

In a single-purpose crane, as, for example, one for grabbing duty, the maximum working load will be constantly handled, and there will be no light-working periods, but for general purpose cranes the average load lifted will usually be far below the maximum load for which the crane has been designed. It would appear to be logical and correct, therefore, to adopt larger bearing surfaces, larger boiler or motor capacities and ratings in the former case than in the latter, and economy in first cost of the latter type would thereby result without any detriment to the value of the service rendered.

We see, therefore, that whilst structurally and statically "maximum load" can have but one meaning, in service the power requirements and the wear

and tear depend not upon the value of the maximum load but rather upon the average load over a given period—that is to say, upon the "load factor" of the machine.

(2) *Impact.*—When observing a crane at work, one cannot fail to be impressed by the importance of an intelligent appreciation of impact loading in estimating the maximum stress and the range of stress to which various members will be subjected. As in bridge design, the ratio of impact loading to dead loading can rarely be closely determined, yet it is possible to make reasonable assumptions based upon experience and experiment, and from them to establish convenient and simple formulæ of impact coefficients for use in calculation. Among secondary loadings we must include the force of the wind, provision for which may well follow bridge practice, and we may, further, have to consider the effect of other external conditions, such as badly laid tracks, &c.

(3) *Speeds.*—Power cranes should be arranged to secure the greatest possible economy by saving not only labour but time; it will usually happen that the value of the time saved is far greater than the cost of the power expended in saving it, notably in the case of dock-side cargo-handling cranes in conjunction with which a large outlay on power would be abundantly justified in securing a quick "turn round" of a valuable vessel. For given working conditions, there can usually be arranged operating speeds that secure the greatest convenience, economy and safety.

An inquirer does not very often specify the speeds that he desires, and it is comparatively rare for him to describe clearly and fully the work that the crane will have to perform; consequently, each maker's offer will reflect his particular conception of the problem. Great diversity inevitably results.

To meet such cases it might perhaps be convenient to tabulate standard speed combinations representing good average practice appropriate to various loads, types of crane, and application. These speeds could be classified simply as "fast," "medium," and "slow," and could thus be easily referred to if considered appropriate. Such a classification would be useful as a means of reducing the variable factors to a reasonable number. It is a common fallacy to assume that high nominal speeds of themselves ensure rapid working. On short lifts or travels, acceleration becomes of far greater relative importance than maximum speed, which latter indeed may never be actually attained in practice.

High acceleration and retardation, although frequently desirable, nevertheless, impose heavy inertia stresses on the machinery and structure, and on that account it is important that the rate of acceleration should be fixed by careful consideration and not be in excess of ascertained requirements.

(4) *Safety.*—It is unnecessary to insist upon the paramount importance of safety under all conditions. The potential danger residing in a crane is very great. It is practically impossible to maintain a crane in a "fool-proof" condition, even if at the outset of its career its operations have been arranged to be almost entirely automatic. As in other machines a large measure of safety can be secured by correct design and the provision of a satisfactory factor of safety.

In crane design the correct construction and rating of the brakes to their duty is specially important if safety is to be ensured, and might usefully be regulated by an accepted specification which would also concern itself with desirable and safe margins of stability for cranes of the locomotive and portal types. Safe-load indicators should probably be made obligatory and overloading and over-travel safeguards would be classified and regulated. In the further interests of safety, a proper field of vision for the operator would be insisted upon, and controls would be required to be placed in a convenient position, and the resulting effect of their operation should, where possible, be made quite obvious. Proper attention to these latter requirements would have the useful effect of increasing the overall speed of operation which would compensate for their cost.

It is regrettable that many owners do not appear to realise properly the responsible nature of a crane driver's task, and frequently entrust this work to men upon whom no reliance can be placed. In most cases the control is so simple that no great degree of skill is required, and, consequently, a suitable man soon acquires proficiency and earns his pay chiefly on account of his reliability and coolness in emergency. If the driver is reckless and irresponsible, he jeopardises not only his own life, but that of others, and the public is clearly entitled to be protected from such unnecessary risks.

(5) *Stresses, &c.*—Crane design presents many special problems to the engineer, and regarding many of them there cannot be said to be any generally accepted practice at present. As an instance, the design of the top flange of an ordinary overhead travelling crane presents a very intricate and interesting problem in column design, in which secondary stresses in two planes, and many other complications are involved. The design of a crane jib may be regarded as another comparatively simple matter, but it also involves certain assumptions that on careful investigation may prove to be unwarranted.

In the solution of such problems the assistance of a specification embodying the experience of recognised experts, backed up by the results of experience and possibly by special tests, would be most helpful.

(6) *Workmanship.*—Here, again, crane design presents special problems. We may usefully adopt standard tolerances in construction, so far as they can be properly applied, but we have in many instances to consider the effects of unavoidable deflection of supports, heavy load concentrations and the abuse and neglect to which some types of cranes are specially subjected.

Thus, fine limits that would be entirely suited to rigid machine tool construction to secure high accuracy of alignment, may well be utterly out of place and wasteful on a crane, and, again, a badly fitting screw thread that would cause merely annoyance in connection with some detail of a machine tool, might in the case of an important crane part easily cause a serious disaster.

(7) *Testing.*—Much time may be wasted and much essential information may be lost by a lack of method in testing cranes; frequently, the time available is very short, since the machine may be due for immediate shipment. Consequently, the value of method is enhanced. All machinery tests should preferably be of a progressive nature, especially in the case of new machines. Preliminary moderate loading will probably suffice to reveal any glaring defect or oversight without causing a serious accident, and the run will work down some of the newness of the bearing surfaces; then, if the general correctness of the machine is apparent, the test load may be applied and manœuvred with confidence, and reliable observations are more likely. It should be remembered that the testing of a crane should be arranged, not only to reveal its strength, power and speed, but also its general handiness, response to control and safety.

(8) *Definitions.*—This section may be regarded as of minor importance, yet it is common experience that frequent misunderstandings result from the unscientific use of common terms, and uniformity thus acquires a commercial value.

In conclusion, the writer would emphasise the value of suitable coding in conjunction with a standard crane specification. Such a development is entirely feasible. At present the overseas buyer finds himself in a very unsatisfactory position for buying cranes in the English market, and it would appear to be possible for our own manufacturers to improve matters considerably to their great advantage.

The cable code linked to the specification should not attempt to cover more than the provisions of the latter; there are many good codes available for commercial phrases. A signal word would indicate reference to the standard specification in what followed, whilst code words or groups would indicate pages and paragraphs of the specification.

For reference to crane types and details, good use might be made of one of the excellent six-language illustrated technical dictionaries that are in use in many offices. They contain excellent outline diagrams properly paged and numbered for reference. Such numbers could be combined to form a ready-made and convenient code, having the added advantage of significance in many modern languages.

Assuming that British crane makers had generally adopted the specification as an accepted basis, the overseas buyer would find himself in a greatly improved position to deal in the English market, for by means of the code he could:—(1) Transmit an entirely satisfactory inquiry to his London buying house, which could then (2) broadcast this inquiry to crane makers in the most concise and satisfactory manner. (3) The quotations received would be on a common basis and strictly comparable, and would cover a reliable product.

The production and success of a standard crane specification depends entirely upon the co-operation and goodwill of British crane makers, and the writer can only express the hope that in this brief article he has been able in some degree to indicate possibilities and to arouse interest in a development, that, if wisely undertaken, could not fail to promote efficiency, should facilitate overseas trade, and might by its operation help to increase the deservedly great international reputation of British cranes.

High Head Hydro-Electric Scheme in Ceylon.

An interesting hydro-electric undertaking which will involve the utilisation of a head of 2050ft. has for some little time now been in progress in Ceylon. The particulars contained in what follows have been obtained from a description of the scheme, which appeared in a recent issue of our contemporary, *The Times of Ceylon*.

The necessary water is to be obtained from two streams which, though generally known as the Aberdeen and the Laxapana, are really named the Kehelgamu-oya and Maskeliya-oya respectively. Both of them rise in the central plateau of the Island, at an elevation of some 6000ft. They fall rapidly in gradually converging valleys, until they meet and form the upper reaches of the Kelaniganga at an elevation of about 400ft. The idea is to take advantage of the rapid fall and proximity of these two streams to convey the water by conduits to a point on the ridge dividing the two valleys, where the combined flow can be concentrated and led down the hillside in pipes to the power-house. In the first instance a gravity section masonry dam, known as the Norton Dam, is being built on the Kehelgamu-oya at a point where the stream runs through a deep and narrow rocky gorge. It will have a spillway throughout the length of its crest, with a roadway carried on piers above it. It will have a maximum height of 75ft., and will, it is said, impound sufficient water to deal with a daily peak load of over 40,000 kilowatts with minimum flow, which would mean a flow at the rate of over 155 million gallons per day, allowing an efficiency of 80 per cent. The intake to the outlet conduit, which is to be provided with rough and fine screens, control gates, &c., is to be placed 150 yards above the dam. From the dam to the forebay above the power-house the conduit is to be a covered channel, built either of concrete or of masonry in cement, as circumstances may require, the inner surface in either case being made smooth. The conduit will not be under pressure; indeed, spillways are being provided at intervals to prevent it from being subject to pressure. It will be made of sufficient capacity to carry enough water to provide for a peak load of 50,000 kilowatts.

The forebay is to consist of a tunnel driven through Morahenagama Hill, and terminating at the outlet end in a built penstock chamber or surge tank, the outer walls of which will carry the penstock sluices. This chamber will be divided into two by a wall, and each half of the chamber will have its own inlet and scour valves, so that either may be laid off for cleaning, or when otherwise necessary, without interfering with the other. Steel pipes 40in. in internal diameter will connect the surge tank with the power-house. At first only two lines of pipes are to be laid, but for the full scheme there are to be six. The lineal length of the pipes, from the forebay to the power-house, is 5250ft., and the vertical fall 2050ft., the slope being described as unusually even.

There is, at the spot chosen for the power-house, an area of some 6 acres of level ground, which is 20ft. above the highest recorded point reached by the river when in flood. Rock foundations can, it is said, be had at a depth of 10ft. below the surface of the ground. Our contemporary does not mention the number of hydro-electric units which are to be installed in the first instance, nor does it state the nature of the turbines which will be employed. It does say, however, that, at the completion of the first stage the output of the station will be 12,000 kilowatts as a 24-hour load.

Work for the second stage will include:—(*a*) The construction of a reservoir at Glencairn; (*b*) the extension of the penstock chamber; (*c*) the laying of an additional line of 40in. pipes; and (*d*) the extension of the power-house, generating plant, &c. The dam at Glencairn on the Kehelgamuwa ganga will be of similar construction to the Norton Dam. The position picked for it is in a narrow gorge, which has a rock bottom. At the completion of the second stage the power-house will be able to supply 34,000 kilowatts as a 24-hour load, the total capacity of the plant installed being 52,000 kilowatts.

Under Stages 1 and 2 it is proposed to deal, eventually, with the full flow from the Aberdeen or Kehelgamu-oya Valley. In Stage 3 the flow from the Laxapana or Maskeliya-oya Valley will be taken in, the result being that the capacity of the power-house will be more than doubled, the total capacity of the plant installed being 104,500 kilowatts, and the total 24-hour output raised to 71,300. The necessary work will include:—(*a*) The building of a dam on the Maskeliya-oya; (*b*) the construction of an intake at Hapugastenna on the Laxapana, and of a conduit to the penstock chamber; (*c*) the extension of the penstock chamber, and, of course, the laying of additional pipe lines.

It is expected that Stage I. will be completed in from three to four years. The other two stages will be proceeded with as and when the demand for power warrants their being undertaken.

SIXTY YEARS AGO.

In our issue of June 2nd, 1865, we recorded the completion of the manufacture of the Atlantic telegraph cable at the East Greenwich works of the Telegraph Construction and Maintenance Company, Limited. The cable, upwards of 2300 miles in length, had been manufactured, tested and passed into the iron tanks prepared for its reception on board the steamship Great Eastern, "without the slightest hitch or difficulty." From an electrical point of view the cable was stated to have surpassed all anticipations, a result ascribed to the improvement effected in the electrical properties of gutta-percha since the date of manufacture of the Persian Gulf cable. With possibly some prevision of the temporary failure which attended the laying of this cable, we paid close attention to its mechanical, as distinct from its electrical features, for in the mechanical features we saw "the question which practically, under present conditions, is perhaps of greatest moment in relation to the success of this enterprise and of future undertakings of a similar character." . . . Towards another great enterprise of the day—the construction of the Suez Canal—we expressed ourselves a little less kindly, a little more critically of ultimate success. We characterised as ambiguous, to say the least of it, M. de Lesseps' announcement that a communication was already open between the Mediterranean and the Red Sea, and that he had passed from one to the other in a steamboat in the space of twenty-four hours. The Suez Canal, we declared, was not open, and it was impossible to say when it would be opened. M. de Lesseps' journey was, it seems, performed on a 20ft. steam launch, and was accomplished by way of the fresh water canal intended to convey the waters of the Nile through the desert. With the suppression of forced labour for the digging of the canal, M. de Lesseps had resorted to the use of steam-driven excavating machinery, but in the absence of information concerning the construction of that machinery, we reserved judgment as to when the canal would, if ever, be completed. The tasks yet to be accomplished, we said, were enormous, and when in due time they were finished, the difficulty of keeping the canal in repair would be almost as great. It is perhaps worth adding that last year—1924—the gross receipts of the Suez Canal Company amounted to over 508 million francs, and that the expenditure on the canal for upkeep and improvements was a little in excess of 60 million francs. The dividend on each share works out at the handsome figure of 327f. or over 65 per cent per annum.

Main Line Railway Electrification.

By Sir PHILIP DAWSON, M. Inst. C.E., &c., Consulting Engineer, and
S. PARKER SMITH, D.Sc., M.I.E.E., Professor of Electrical Engineering, Royal Technical College, Glasgow.

No. V.—GERMANY.*

1. Historical: Reasons for Electrification.

The Prussian Railways Administration began to consider the electrification of main-line railways at an early date. It took part in the trials on the Wannsee Railway in conjunction with the Siemens and Halske Company in 1900–1901, when medium-tension direct current was employed. The famous Marienfelde-Zossen high-speed trials on a 23 kilom. line near Berlin took place about the same time with 10,000-volt three-phase supply. In 1903, experiments in conjunction with the Union Elektrizitäts Gesellschaft with single-phase current at 10,000 volts, were carried out on the Niederschöneweide-Spindlerfeld line, also near Berlin. The results of the trials were so successful that the Railway Administration resolved to equip the local Hamburg line, Blankenese–Ohlsdorf. Supply at 6000 volts, 25 periods, single phase was used, and 140 motor-coaches of a total power of about 48,000 horse-power were placed in service.

The Administration then studied further lines suitable for electric haulage. At the beginning of 1909 the Ministry of Public Works decided upon the adoption of the high-voltage, low-frequency, single-phase system, as the states of Baden and Bavaria, and also Austria, Switzerland and Sweden, had already done. The first line to be put in hand was the Dessau–Bitterfeld section, the construction of which was begun in January, 1910, and later the Silesian Mountain Railways were electrified between Lauban and Königszelt.

In Bavaria electric traction was initiated in 1899–1900, when the Murnau–Oberammergau line, 24 kiloms. long, was equipped. Working started early in 1905. The Bavarian State Authorities decided to develop about 100,000 horse-power of hydraulic power for railway electrification, and in April, 1908, the Minister of Transport laid down a detailed report on the suitability of main-line railway electrification, and gave a programme for the order in which these developments should take place. In this report the 40 kilom. line Salzburg–Bad Reichenhall–Berchtesgaden was mentioned for trial purposes. The Salzburg–Reichenhall section is fairly level, but the last part to Berchtesgaden is of a mountainous character, so that the whole line was eminently suited to trials of rolling stock, both on level lines and on gradients up to 4 per cent. This electrification was begun in 1911, with the construction of a hydro-electric station on the river Saalach. A dam on the river produced a storage lake, 2.6 kiloms. long and 0.45 kilom. broad, with a head of 20 m. and a mean flow of 16.4 cubic metres per second. An output of 3200 horse-power (mean) was obtained, or 7000 horse-power on peak loads. The station supplied three-phase energy at 20,000 volts, 50 periods, for lighting and power in the surrounding district, and also single-phase current at 15,000 volts, 16⅔ periods, for feeding the railway.

The Mittenwald Railway (Innsbruck–Scharnitz–Mittenwald – Garmisch Partenkirchen – Griesen – Reutte) lies partly in Germany (Bavaria) and partly in Austria (Tyrol). The Bavarian part was built by the State, while that in Austria was constructed by Dr. Josef Riehl, of Innsbruck. This line has been worked electrically since the year 1912.

In 1910 the Baden State Railways Administration completed the electrification of the Basle–Schopfheim–Zell railway (known as the Wiesentalbahn), together with the Schopfheim–Säckingen branch. Power is obtained from the Rhine, at a station Augst-Wyhlen, 8 kiloms. above Basle.

The electrification schemes proceeded rapidly until the beginning of the war, when all work was stopped, and operation of some of the existing lines was suspended, the copper conductors being dismantled and used for military purposes. The suspension occasioned in this manner on the Silesian Mountain Railways was partially relieved by the complete dismantling of the copper conductors on the Dessau–Bitterfeld line.

After the federalisation of the railways of Germany on April 1st, 1920, the electrifications begun by the various states were continued by the Reich. The position at the end of 1921 is shown in Table I. Later extensions and additions are shown in Section 4.

The reasons given to justify electrification are:—

(1) That the annual working costs are less with electric working than with steam.

(2) That valuable minerals—*e.g.*, coal—in the country are conserved.

(3) That by introducing electric traction without increasing the number of tracks, the carrying capacity of the line is considerably augmented.

Amongst important suburban and local lines electrified or under construction, the following may be mentioned:—Berlin (Potsdamer Bahnhof)–Grosslichterfelde Ost (direct-current, 550 volts); Berlin (Stettiner Bahnhof)–Bernau and Hermsdorf (direct-current, 800 volts); Blankenese–Altona–Hamburg–Ohlsdorf–Poppenbüttel (single-phase, 6000 volts, 25 periods); Altona–Altona Harbour (goods line) (single-phase, 3000 volts, 25 periods).

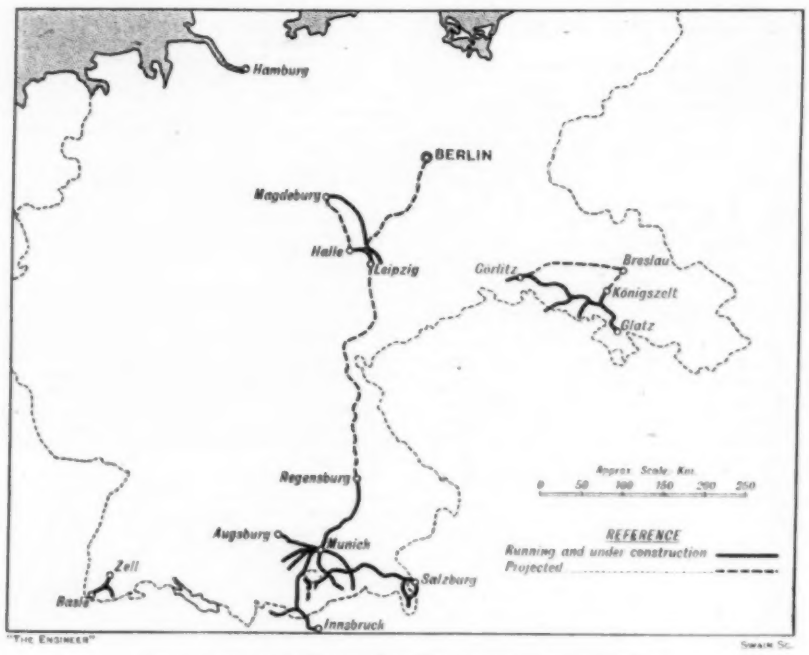


FIG. 1—MAP OF GERMANY SHOWING ELECTRIFIED RAILWAYS

Table I.—*German Railway Electrifications, Running and Under Construction, on December 1st, 1921 (Single-phase).*

Line.	Chief route.	Length, kiloms.	Locomotives running or ordered.
Wiesental	Basle–Zell, Schopfheim–Säckingen	49	15
Mittenwald (Bavarian section)	Scharnitz–Griesen	37	5
Reichenhall ..	Freilassing–Berchtesgaden	34	22
	*Schellenburg–Königsee ..	17	10†
Bavarian	Munich network	318	105
	Munich–Regensburg ..	138	
Central Prussian	Halle – Leipzig – Magdeburg	174	62
Silesian	Schlauroth – Görlitz – Königszelt and branches	264	77
		1031	286 10†

* Direct-current line. † Motor coaches.

2. Choice of System.

A report of the decisions on the question of system was published by the Verein Deutscher Eisenbahnverwaltungen in December, 1921. It had been decided to reconsider the decision arrived at previously in view of the foreign developments after the war. While some countries—Switzerland, Sweden and Austria—had definitely standardised the single-phase system, others—England and France—had been influenced by the 3000-volt direct-current developments in America, and had standardised 1500-volt direct current for their future electrifications. Again, a further consideration was necessary in view of the fact that large three-phase power stations in Central and Western Germany, installed for war purposes, were no longer fully loaded.

In order to study the question from every point of view, the Minister of Transport in February, 1921, invited into congress a large number of well-known German and other engineers, who were experts in railway operation, motor design or telephone engineering. They came to the unanimous conclusion that for main-line electric traction the straight single-phase system should be retained, as already installed in some districts at 15,000 volts, 16⅔ cycles. The two most important matters considered were transmission and interference. The decisions on these points may be summarised as follows:—

In Germany there is no supply large enough at present to meet all the heavy traction requirements—even the Bavarian scheme is insufficient—without increasing the capacity of the existing lines and cables and installing new plant. In these circumstances, it is clear that the current supply should be chosen which best suits the railway—*i.e.*, straight single-phase. The transmission lines for this system are cheaper than for three-phase supply; the masts are smaller, and only two conductors are required, which means fewer insulators and greater safety. In the sub-stations there are only two-thirds the number of switches, which reduces the liability to faults. Admittedly, the generators and transformers are more expensive, but this point is of less importance where the transmission lines are of considerable length. Moreover, in traction systems a greater pressure drop can be allowed, so that a saving in copper or aluminium is effected. The low-frequency single-phase system is also considered the best for extensions and developments, and gains reliability by being independent of industrial power.

With regard to the interference with communication circuits running parallel to the railways, a large number of methods have been proposed to alleviate this objectionable phenomenon. Apparatus may be connected in the traction circuits to prevent the current collection from causing inductive interference or the communication lines may be provided with

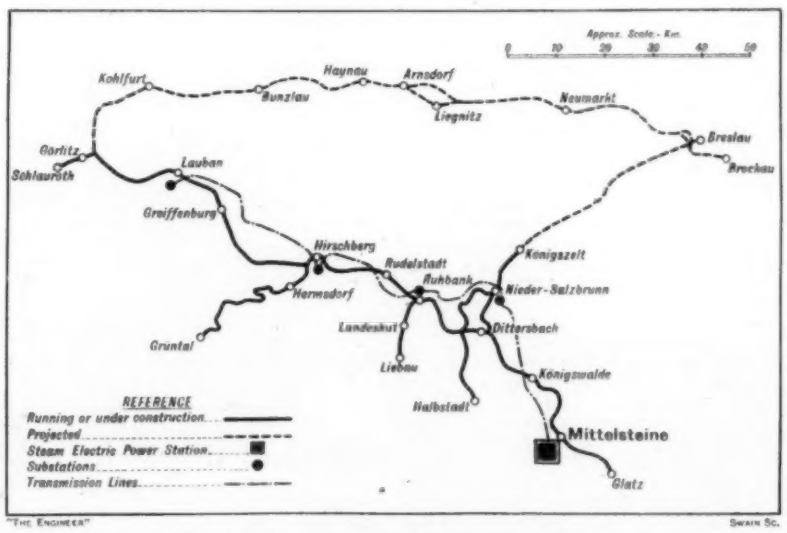


FIG. 2—SILESIAN MOUNTAIN ELECTRIFIED RAILWAYS

* No. IV. appeared January 23rd, 1925.

more or less sensitive equipment to render harmless the disturbances to the telephonic apparatus. In America and Sweden, such devices have been very thoroughly investigated, and some valuable data have been collected. Experiments have also been performed on the Silesian Mountain Railways.

It is questionable, however, whether it is safe to run communication circuits alongside a high-tension contact line in any case, as the danger to telegraph engineers or linesmen, during maintenance work or improvements, is considerable. The possibility exists that a bare telegraph line may accidentally touch the high-voltage contact wire. Thus it is considered best to remove telegraph, telephone and train-movement circuits away from the track to a safe distance.

The main-line traction system was therefore standardised as single-phase, 16⅔ cycles, with a nominal contact line voltage of 15,000 volts. The following limits were fixed :—

Transmission Voltage.—110 kilovolts, or 55 kilovolts for short distances. These figures were also agreed upon by the Railway Administrations in Switzerland and Sweden.

Contact Line Voltage.—Normal value 15 kilovolts ; maximum, 16.5 kilovolts (*i.e.*, + 10 per cent.) ; minimum, 12 kilovolts (*i.e.*, — 20 per cent.). With this pressure the sub-stations can be spaced 40 kiloms. to 60 kiloms. apart. All electro-magnetically actuated gear must operate satisfactorily at a contact line voltage of 10.5 kilovolts.

Frequency.—16⅔ cycles per second, with a permissible variation of + 5 and — 10 per cent.

TABLE II.—*German State Railways : Main Line Electrification.*

No.	Section.	Date opened for electric traction.	Route length, km.	No. of tracks.	Gauge, m.	No. of intermediate stations	Mean distance between stations, km.	Max. grade, °/₀₀	Min. curve radius, m.	Type of rail.	Rail wt., kg./m. Rail length, m.	Max. allowable speed, km./hr.	Contact line. Current, voltage frequency.	Contact line.	Contact line. Return	Contact line. Description and spacing of supports.	Contact line. Insulation.
1	Silesian Mountain Railways. Schlauroth–Königszelt and branch lines	1922	264	2 for 164 km. 1 for 100 km.	1.435	49	4.98	25 main line 25 branch line	182	Vig.	41.1/15	90	Single-phase, 15,000 v., 16⅔ per.	Compound catenary (S.S.W.) Simple catenary (A.E.G. and B.E.W.) Profile hard copper contact wire, 80 or 100 mm.² Catenary cable, 40 mm.² bronze or 50 mm.² galvanised steel Droppers, copper or bronze wire, 5 mm. dia.	Rails	Iron lattice or wood masts, spaced 80 m.	Double
2	Magdeburg–Leipzig–Halle ; Wahren–Engelsdorf	1922	177	2	1.435	33	4.92	10	245	Vig.	41.1/15	100 130 for special tests	Single-phase, 15,000 v., 16⅔ per.				
3	Wiesental Railway Basle–Zell and Säckingen	1910	49	1	1.435	18	2.7	10	270	Vig.	41.1/15	80	Single-ph., 15,000 v., 15 per.				

TABLE II. (*continued*).—*German State Railways : Main-line Electrification.*

No.	No. of feeding points.	Power supply. Feeding points.	Mean length of line per feeding p km.	Feeding lines.	Transmission lines.	Power stations.
1	4	*Transformer sub-stations—Niedersalzbrunn, Ruhbank, Hirschberg, Lauban* In each, 2 or 3 transformers, single-phase, 16⅔ per., 80,000/16,000 v. ratio	65	—	80,000 v., single-ph., 16⅔ per. line :— Mittelsteine – Niedersalzbrunn – Ruhbank – Hirschberg–Lauban	*Mittelsteine* (steam)— 10 boilers 4 turbo sets, 4000 kw., single-ph., 3150 v., 16⅔ per. 4 transformers, 5000 kVA. 3150/80,000 v., 16⅔ per., single-ph.
2	3	*Transformer sub-stations*— 60,000/15,000 v. ratio, 16⅔ per. single-phase *Wahren :* 4 transformers, each 1500 kVA *Marke :* 3 transformers, each 1500 kVA *Gommern :* 2 transformers each 1800 kVA	59	—	60,000 v., single-ph., 16⅔ per. lines— Muldenstein – Bitterfeld Bitterfeld–Wahren Bitterfeld–Marke–Gommern	*Muldenstein* (steam)— 20 boilers 5 turbo sets, 3300 k.w., single-ph., 3300 v., 16⅔ per. 9 transformers, 2000 kVA. 3300/60,000 v., 16⅔ per., single-ph.
3	1	Basle converter sub-station, converting from 3-phase, 6800 v., 50 per., to 1-phase, 15,000 v., 15 per. Buffer battery, 750 v., 2200 A-h	49	Along track from Basle to Schopfheim	Cable from power station, Augst-Wyhlen, to Basle, 8 km., three-phase, 6800 v., 50 per.	*Augst-Wyhlen* (hydro-electric) on river Rhine

For the contact wire supports, the spacing should be 90 m. on straight track.

Locomotives.—Six standard locomotives were developed. Details are given in Section 6.

These considerations are for main-line railways. For local lines and close railway networks, the system should be chosen for each individual case. For instance, the Berlin Stadt-, Ring- and Vorortbahnen will be electrified on the direct-current system (800 volts, third rail), on account of their intense traffic. On the city line, forty trains per hour are required during the peak load, giving a headway of but 90 seconds. As single-phase motor coaches cost more than low-voltage direct-current stock, the direct-current system shows to advantage.

FIG. 3—BAVARIAN ELECTRIFIED RAILWAYS

FIG. 4—MAGDEBURG - LEIPZIG - HALLE RAILWAY

3. EXTENT OF THE PRESENT ELECTRIFICATION.

In Fig. 1 a general map is given, showing the lines in operation or under construction, and those which it is intended to electrify in the future. The individual portions are shown in greater detail in Figs. 2, 3 and 4. By far the biggest scheme is that in Bavaria, where a number of lines radiating from Munich will be supplied with power from hydro-electric stations on the Middle Isar River.

Data of the various lines are given in Table II. and of the locomotives in Table III.

4 (A). SILESIAN MOUNTAIN RAILWAYS.

The electrified portion of the Silesian Mountain Railways forms part of a great electrification scheme in the south-east corner of Germany. The construction was undertaken in 1910, together with that of the Dessau–Bitterfeld line, by the Prussian State Railways Administration in order to gain experience with electric traction, both on the heavy gradients in the Riesengebirge and on level track. Before the outbreak of war in 1914 the work was nearly completed, and the operation of the Niedersalzbrunn–Halbstadt section had been begun. The war not only compelled the cessation of the construction work, but resulted in the dismantling of a great part of the copper conductors for military purposes. Only on the Niedersalzbrunn–Halbstadt and Königszelt–Dittersbach sections was it possible to provide any service at all.

After the war the work was taken up again, and in spite of material and labour difficulties, a great

GERMAN FEDERAL RAILWAYS—ELECTRIC LOCOMOTIVES

TABLE III.*

Rolling stock, Series Nos.	No.	Axles: Driving.	Axles: Pony	Type.	Weight: Total, tons.	Weight: Adhesive, tons.	Weight: Electr. equip., tons.	Weight: Axle, tons.	Weight per H.P., kg.	Length over buffers, m.	Total wheel base, m.	Wheel diam.: Driving, m.	Wheel diam.: Pony, m.	Motors.	No. of motors.	Motor volt'ge, v.	Loco. H.P. (1-hour), H.P.	Tractive effort (1-hour), kg.	Tractive effort (max.), kg.	Speed (1-hour), km./hr.	Speed (max.), km./hr.	Drive.	Gear ratio.	Speed regulation.	Current collectors.	No. of transformers.	Cooling of transformers.	Braking.
ES 21001–10	10	4	2	1 A A A A 1	101	73.6	—	18.4	42	16.3	12.6	1.64	1.0	Single-phase neutralised series	4	660	2,400	8,800	13,150	73.5	110	Buchli	2.63	Transformer tappings	Pantographs	1	Oil	Air
ES 51–55	5	3	4	2 C 2	115	55.2	—	18.4	38.4	15.75	12.45	1.6	1.0		1	319	3,000	11,400	13,000	71	110	Side rod	—	Tappings and brush shift		1	Oil	Air
EP 21501–35	35	4	4	2 B B 2	126	73.6	—	18.4	53	17.21	13.6	1.4	1.0		2 twin	420	2,300	12 600	10,500	49	90	Geared jack shaft side rod	2.87	Transformer tappings		1	Oil	Air
EP 20006–24	10	3	2	1 C 1	77.5	62.5	—	17.5	64.5	13.01	8.95	1.4	0.85		2	660	9,500	9,500	50	75		3.27			1	Oil	Air
EG 22001–25, EG 701–12	37	4	2	1 B + B 1	107	73.6	—	18.4	56	16.0	12.1	1.4	1.0		2	378	1,920	14,400	17,000	36	65		2.61			1	Oil	Air
—	2	4	3	2 D 1	106	70	—	17.5	53	14.025	10.95	1.25	0.85		2	400	1,920	14,400	18,000	36	65	Side rod	2.8	Dörr regulator Transformer tappings		1	Oil	Air
EG 22501–10, EG 380–94	30	6	0	C + C	115	115	—	19.1	50	16.7	11.76	1.25	—		2 twin	420	2,300	20,700	27,000	30	55		4.04			1	Oil	Air
EP 20001–5	5	3	2	1 C 1	70	45	—	15	140	12.25	9.0	1.05	0.85		1	383	500	1,600	9,000	45	60		—	Induction regulator		1	Oil	Air
EP 20101–04	4	3	3	1 C 2	82.3	51.3	—	17.1	126	12.3	9.4	1.1	0.85		1	530	650	1,825	8,000	53	80	Side rod	—			1	Oil	Air
EP 20121–24	4	3	3	1 C 2	94	48.9	—	16.3	94	13.4	9.75	1.15	0.85		1	504	1,000	1,860	9,000	80	80	Nose suspension	—			1	Oil	Air
EG 20201–2	2	4	0	A A — A A	56	56	—	14	98	10.99	7.0	—	—		4	423	580	460	9,300	36	50	Geared jack shaft side rod	5.24			1	Oil	Air
EG 20221–2	2	4	0	B + B	65	65	—	16.2	93	12.54	9.2	1.25	—		2	736	700	1,110	8,000	30	50		3.5	Transformer tappings		1	Air	Air
ES 2	1	2	3	2 B 1	72.7	32.3	27	16.2	104	12.5	9.0	1.6	1.0		1	500	700	2,000	4,000	78	110		—			1	Oil	Air
ES 9–19	11	3	2	1 C 1	88	53.9	38	18.2	84	12.425	8.13	1.35	1.0		1	620	1,050	1,980	8,000	100	110	Side rod	—			1	Oil	Air
EG 505	1	4	0	D	67.2	67.2	30	16.8	190	10.5	4.8	1.05	—		1	388	353	1,450	8,750	50	50		—			1	—	Air
EG 511–57	27	4	0	B + B	67.5	67.5	34.5	16.9	75	11.6	8.3	1.35	—		2	530	900	742	14,000	50	50	Geared jack shaft	4.45	Induction regulator		1	Oil	Air
EP 202–8	7	3	2	1 C 1	84.4	51.5	37	17.2	115	12.03	8.0	1.2	1.0		1	592	730	1,600	11,000	80	90	Side rod	—	Transformer tappings		1	Oil	Air
EP 209/10, 211/12	2	4	3	2 B + B 1	111.4	72.1	50	18.0	51	16.49	12.89	1.7	1.0		2	367	2,200	2,400	14,000	55	90	Geared jack shaft	2.8			1	Oil	Air
EP 235	1	4	3	2 D 1	108.4	65.8	38	16.4	48	14.4	11.25	1.25	1.0		1	346	2,250	6,000	14,600	55	90	Side rod	—	Brush-shift		1	Air	Air
EP 236–46	11	4	3	2 D 1	114.2	73.3	—	18.3	51	14.8	11.4	1.25	1.0		1	317	2,250	5,000	18,000	65	90		—			1	Air	Air
EP 247–52	6	4	3	2 D 1	119.7	73.5	—	18.4	63	15.05	11.65	1.25	1.0		1	608	1,900	5,000	12,000	40	90		—			1	Air	Air
EG 531/2 — 569/70	10	6	0	C + C	98	98	42	16.3	79	15.93	11.43	1.25	—		2	810	1,240	1,024	20,000	28.7	50	Geared jack shaft	4.83	Transformer tappings		2	Air	Air
EG 571–9	9	6	0	A A A + A A A	114	114	56	19	110	17.28	12.4	1.3	—		2 twin	325	1,040	1,380	21,000	20	50	Nose suspension	5.27			2	Oil	Air
AII 1–3, 5–9	8	3	2	1 C 1	71	42.9	32	14.3	117	12.4	9.0	1.05	0.85	Repln. single-phase neutralised series	2	324	600	1,200	8,750	60	60	Side rod	—	Induction regulator		1	Oil	Air
AII 4	1	3	2	1 C 1	73.8	47.1	32	15.7	123	12.4	9.0	1.05	0.85		2	324	600	1,200	8,750	60	60		—			1	Oil	Air
EP 213–4	4	4	0	B + B	73.7	73.7	—	18.4	80	12.9	9.1	1.5	—		2	310	920	870	11,000	65	65	Geared jack shaft	3.54	Transformer tappings		1	Air	Air
EP 215–9	5	4	0	B + B	72	72	—	18	90	13.36	9.36	1.5	—		3	340	860	770	12,200	65	65		3.65			1	Air	Air
EG 538–49	12	6	0	B + B + B	100.7	100.7	44	16.8	89	17.2	13.66	1.35	—		3	266	1,135	1,335	20,000	30.5	50		5.19			2	Oil	Air

* The first seven types are those ordered in 1922–3; the others are those running on January 1st, 1924. H.P. and tractive effort figures for the latter are continuous ratings.

deal has been accomplished. The following sections are now working or are under construction :—

	Kiloms.
Königszelt–Hirschberg, double track	77
Hirschberg–Lauban, double track	52
Lauban–Görlitz–Schlauroth, double track	29
Niedersalzbrunn–Halbstadt, single track	35
Ruhbank–Landeshut, double track	16
Landeshut–Liebau, single track	
Hirschberg–Grünthal, single track	53
Dittersbach–Glatz, double track	51
Total	313

It is intended to electrify also the Görlitz–Bunzlau–Arnsdorf – Breslau and Breslau – Königszelt routes.

These lines are composed almost entirely of curves, there being very little tangent track. The curves are in places as sharp as 188 m. radius, and the gradients reach 2 per cent. on the main line (Lauban–Königszelt) and 2.5 per cent. on branch lines. Express and passenger trains of 500 tons and goods trains of 1200 tons have to be hauled under these conditions. Furthermore, the climate is very severe; the winters are long and snowstorms frequent.

The power is obtained from a steam station at Mittelsteine, on the river Steine, north-west of Glatz. This station belongs jointly to the Allgemeine Electrizitäts Gesellschaft and the Siemens-Schuckert Werke, but will later be taken over by the Railway Adminstration. The coal supply is drawn from the Johann-Baptista mine, 12 kiloms. distant. Single-phase current at 16⅔ periods is generated for the railway needs, and 50-period three-phase power for industrial purposes, including the coal mines. The traction current is generated at 3150 volts, and transmitted to the sub-stations at 80,000 volts. Curtis or Zoelly turbines are used, coupled to 5000 kilovolt-ampère generators, 16⅔ periods, running at 1000 revolutions per minute. Cooling water is obtained from the river Steine. There are four traction generators and a like number of transformers of 5000 kilovolt-ampère capacity, 3150/80,000-volt ratio.

There are four sub-stations, situated at Niedersalzbrunn, Ruhbank, Hirschberg, and Lauban, where two or three 1600 kilovolt-ampère transformers of 80,000–16,000-volt ratio, are installed. The sub-stations feed the contact wires on either side to a distance varying from 20 kiloms. to 50 kiloms., depending on the load.

There are seven different locomotive types—see Fig. 5—either in operation or ordered. They are :—

Passenger locomotives. Number.	Type.	Goods locomotives. Number.	Type.
7	1 C 1	12	B + B + B
18	2 D 1	10	C + C
10	2 B + B 1	9	A A A + A A A
3	B + B		

In addition there are six motor coach trains for local passenger traffic. The end coaches are trailers, each having three axles; while the central motor coach has two driving axles and one pony axle. Data of the Federal locomotives are given collectively in Table III.

The contact line arrangements are shown in Fig. 6. The three types developed by the Siemens-Schuckert Werke (S.S.W.), the Allgemeine Electricitäts Gesellschaft (A.E.G.), and the Bergmann Electricitäts Werke (B.E.W.), as shown diagrammatically, have been employed on all the electrified lines of the Reich, in order to compare them and to develop a standard arrangement. The S.S.W. construction embodies a catenary cable supporting at 6-7 m. intervals an auxiliary wire, which runs about 120 mm. above the contact line. The contact wire is slung from the auxiliary wire by looped droppers to eliminate "hard spots" and to obtain flexibility. The A.E.G. arrangement is rather simpler, being a single catenary cable directly supporting the contact wire by 5 mm. diameter copper droppers. The latter embody two loops in their length, so that vertical flexibility is obtained. In the B.E.W. type, inverted V-loops of small section bronze cable are fixed to looped runners, which traverse on special runway bars. The latter are clamped to the sloping catenary cable in such a manner as to produce a horizontal runway. At the centre of the span these special runways are not required, as the catenary cable itself is practically horizontal. This peculiar construction is intended to allow of the horizontal expansion and contraction of the contact line relatively to the catenary due to extremes of temperature: the catenary cable itself has no tensioning device.

4 (B). BAVARIAN RAILWAYS.

The lines in Bavaria which are electrified or under construction, or are projected, are indicated in the map—Fig. 3. Electric haulage began on the Mittenwald Railway (Innsbruck-Garmisch-Griesen-Reutte) in 1912, power being supplied at 50 kilovolts from the Ruetz hydro-electric station near Innsbruck (Austria). The length of this line is about 100 kiloms.

At the end of1913 the Bavarian State power station at Saalach was ready to supply power for operating the Salzburg (Austria) - Reichenhall - Berchtesgaden line. The Saalach works have two 2000 kilovolt-ampère single-phase traction generators, and a 1700 and a 2000 kilovolt-ampère three-phase generator for general supply in the South-Eastern district of Upper Bavaria. The system adopted for the railways was single-phase at 16⅔ cycles with an overhead conductor pressure of 15 kilovolts, in conformity with other German States which had adopted electrification.

The lines mentioned above were regarded as experi-

mental only, and were intended to provide technical and economical experience for comparison with steam operations, before further extensions were made. As coal reached such an inflated price at the end of the war, and made the Walchensee and other hydro-electric schemes in Bavaria urgent for general power purposes, the Railways Administration had to decide definitely whether it should participate from the outset in developing these works, which were so well suited for traction needs. The knowledge that national interests demanded the conservation and economical utilisation of coal led to the decision to extend electric traction.

The economy obtainable by working the railways from water-power stations was found to be considerable. A steam locomotive, with superheater and feed-water heater, has an efficiency of about 6 per cent.; an electric system, in which electric locomotives are supplied from a steam power station—turbines and lignite coal—has a similar overall efficiency; from a water power source of electric supply, the overall efficiency is, however, about 33 per cent., the water turbine being of great assistance to this end with its efficiency of 85 per cent. or more. Internal combustion engines also show a good efficiency for the development of electric power.

Objection may be raised against present-day figures because of the high construction costs of hydro-electric stations and the probability of a fall in the price of coal. In some cases, however, the power produced in hydro-electric stations can, provided a good load-factor is secured, show material economy over that produced in steam stations. Although the latter need far less capital, they have continually to reckon with high fuel costs, whereas hydro-electric stations have only renewals, upkeep and *personnel*. The installation costs for electric traction must, of course, not be forgotten.

Saalach power station supplies the lines in the region of Salzburg, except the D.C. section, which is fed from Gartenau station. For the new lines radiating from Munich, power stations at the Walchen Lake (Walchensee), and at Aufkirchen, Eitting and Pfrombach on the middle Isar River, are or will be built. The Walchensee Station is well suited for a fluctuating traction load, and also, on account of its storage capacity, for equalising the load with linked river stations having no storage. In this station there are four 12,000-kilowatt traction generators running at 250 revolutions per minute. The Middle Isar Stations are also well suited for a railway load. The heads are comparatively large. In both the Aufkirchen and Eitting Stations there will be two 9000-kilowatt railway generators running at 167 revolutions per minute, while the Pfrombach Station will have two 7400-kilowatt generators. Three-phase generators will also be installed for industrial loads. The stations will be linked by a 110-kilovolt traction line, and each transformer station will receive power from two directions.

The electrified network will comprise the following lines to be undertaken immediately :—

	Kiloms.
Munich–Regensburg	138
Munich–Garmisch	101
Munich–Bayrischzell	78
Munich–Freilassing (for Salzburg)	148
Munich–Diesenhofen	13
Tutzing–Kochel	35
Holzkirchen–Tölz–Lenggries	31
Holzkirchen–Rosenheim	37
Rosenheim–Kufstein	34
Pasing–Herrsching	38

and the lines already in operation :—

Scharnitz–Griesen (Mittenwald)	37
Freilassing–Berchtesgaden	34
Schellenburg–Königssee*	17
Total	741

* Direct current.

The Pasing-Augsburg (62 kiloms.) and Pasing-Geltendorf (42 kiloms.) branches will be undertaken subsequently.

Although the railways will not have their own exclusive stations, their single-phase generators will be separate from those of the general supply. This combination will bring down the cost of the hydraulic works chargeable to the railway.

4 (c). Magdeburg–Leipzig–Halle Line.

The resolution to electrify the Magdeburg-Leipzig-Halle and Wahren-Schönefeld lines in Prussia—see Fig. 4—was made in 1909, and the experimental section Dessau-Bitterfeld was begun in that year, and was the first main line electrification in Germany using locomotives. The Dessau-Bitterfeld line was opened in 1910. A steam power station at Mulden-stein, fired with brown coal from the neighbouring district, was built to supply a sub-station at Bitterfeld. Extensions were progressing until the outbreak of war, after which many interruptions were experienced. For instance, in places where chemical factories were working and the air was damp, the catenary wires became badly corroded. At the end of the war the whole installation was in a poor state.

Reconditioning and extensions were then undertaken, and the lines running or being equipped are :—

	Kiloms.
Magdeburg–Bitterfeld	86
Bitterfeld–Leipzig	33
Leipzig–Halle	38
Wahren–Engelsdorf	27
	174

The total length of track is about 570 kiloms.

There are now three sub-stations : Wahren, Marke and Gommern. Wahren (four 1500 kilovolt-ampère transformers) feeds the whole of the system below Delitzsch, about 12 kiloms. south of Bitterfeld; Gommern (two 1800 kilovolt-ampère transformers)

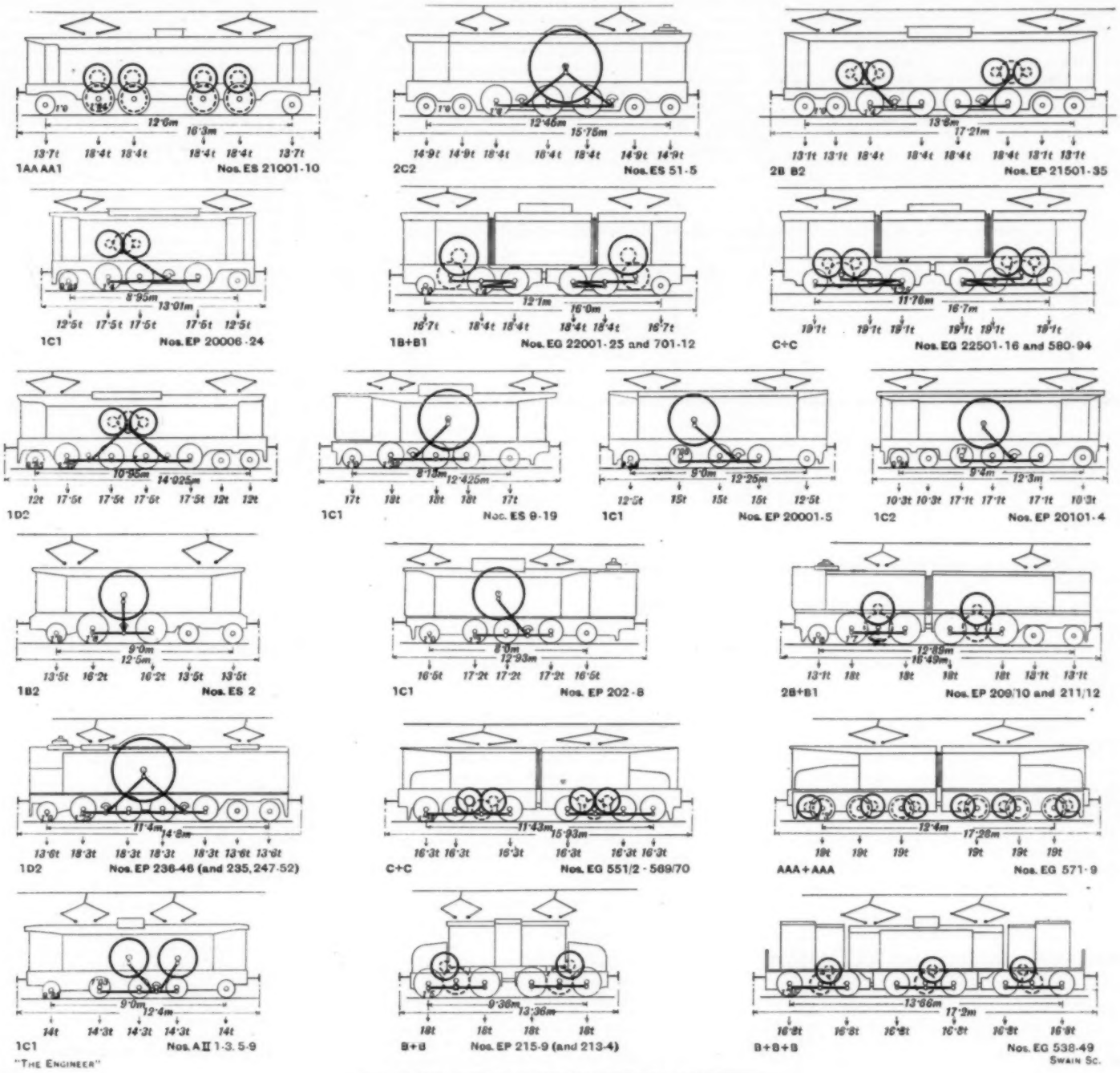


FIG. 5—GERMAN FEDERAL RAILWAYS—ELECTRIC LOCOMOTIVES

feeds the system north of Zerbst ; and Marke (three 1500 kilovolt-ampère transformers) the central part.

In Muldenstein, the central station, 20 boilers fired with raw brown coal supply five 3300-kilowatt sets generating single-phase current at 3300 volts, $16\frac{2}{3}$ periods, which is transformed up to 60,000 volts for transmission to the sub-stations.

For the best utilisation of the power station and repair shops, and by consideration of the bulk of traffic, the line Halle-Cöthen-Magdeburg (86 kiloms.) is to be electrified in the near future. This section would be supplied by sub-stations at Cöthen and Schönebeck, as indicated in Fig. 4.

The rolling stock consists of 27 express and passenger locomotives and 44 goods locomotives ; 22 of the former and 17 of the latter are modelled on the new standard types—1 C 1, 2 C 2 and 1 B + B 1. The locomotives are shown in Fig. 5 and Table III., together with those of the other Federal railways.

4 (D). OTHER LINES.

The Wiesental Railway, Basle–Zell and Schopfheim–Säckingen, was built in 1910. It is a single-

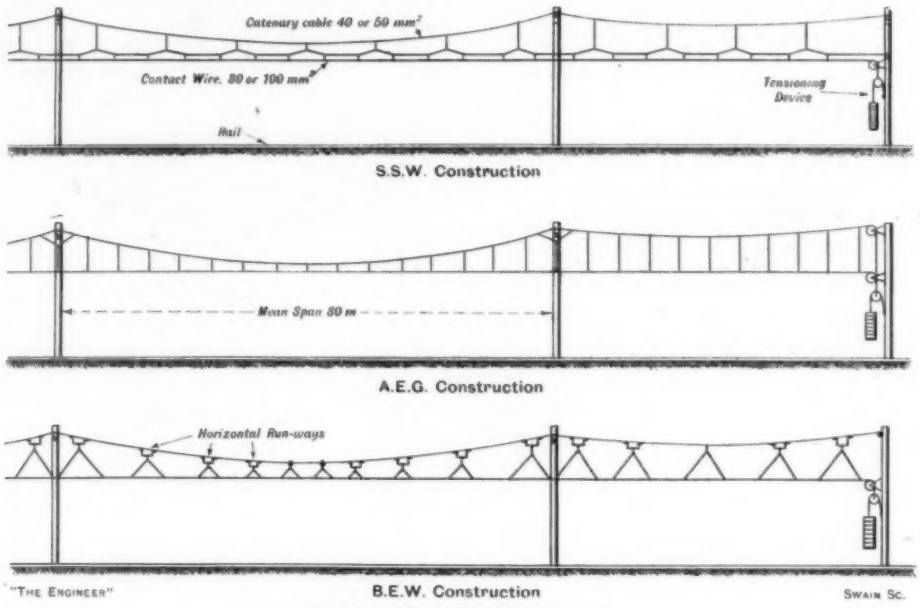


FIG. 6—CONTACT LINE CONSTRUCTION

track line, 49 kiloms. in length. The electric energy is obtained from a hydro-electric station on the Rhine at Augst-Wyhlen, where three-phase current at 6800 volts, 50 cycles is generated. A cable transmission is used from Augst-Wyhlen to Basle sub-station, a distance of 8 kiloms., where the power is converted to single-phase, 15,000 volts, 15 periods. A buffer battery (750 volts, 2200 ampère-hours) is installed in the sub-station. The overhead line work was carried out partly by the S.S.W. and partly by the A.E.G. Twelve locomotives serve for the goods and passenger traffic.

The local line Blankenese-Altona-Hamburg-Ohlsdorf-Poppenbüttel may be mentioned. The total length, double track, is 33 kiloms., and it is worked on the single-phase system at 6000 volts, 25 cycles.

Notes on Variable Speed A.C. Motors.

By N. PENSABENE-PEREZ, M.I.E.E.

WHEN a variable speed drive is required and only two or three-phase supply is available, the electrical power user has the following alternatives to choose from :—(1) An alternating-current to direct-current converting plant and the installation of direct-current motors ; (2) induction motors, having few or definite speeds obtained by pole changing or cascade devices ; (3) slip-ring induction motors, with rotor resistance speed control ; (4) motors of the latter type, with secondary voltage control by means of commutator variable frequency auxiliary machines ; and (5) commutator induction motors. Alternative (1) is obviously only possible for large installations when the expense of a converting plant can be justified. Scheme (2) is generally impracticable for small, high or medium-speed motors on account of the small number of speeds obtainable with a small number of poles. It is practicable for large units generally running at slow speeds, but no continuity in speed variation can be obtained. Efficiencies and power factors are, however, generally low with such method of speed control.

For larger speed range, the third scheme is out of the question, with the cost of power ruling to-day ; in fact, with such a method of speed control, the power wasted in the rotor resistances expressed in percentage of the motor output, is the same as the percentage of speed reduction from the maximum speed. Thus, to reduce the speed to half, the power wasted must be approximately equally to the power used. This, however, is not the only serious defect of this method of speed control, for a motor so controlled loses its shunt characteristics and its speed rises at fractional loads reaching synchronism at no load.

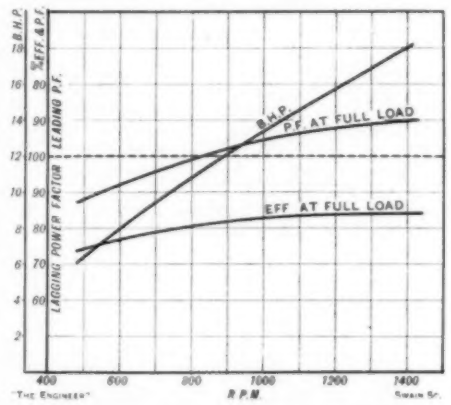
The fourth method is generally a very expensive and complicated one, and is only practicable for larger motors. For small units up to 100 brake horse-power, the last scheme is undoubtedly the most suitable one, as the commutator induction motor can give, without loss of power, a large continuous range of speeds while working with high power factor or leading current and keeping its shunt characteristics at all speeds. Apart from certain improvements, the commutator induction motor is almost as old as the ordinary induction motor, but its development has been hampered by the lack of interest on the part of manufacturers who have been devoting their attention mainly to the latter type on account of its simplicity. Yet this motor, in spite of its commutator, can be made to compete successfully with the induction slip-ring motor, either in reliability or price, if properly standardised. Its performance and capabilities are certainly superior, and with the requirements for high power factor or leading currents to relieve the net works of the burden of carrying enormous wattless power, its use should increase in the near future.

For the present, at any rate, it undoubtedly has a field for variable speed drives. In its simplest form, this motor is nothing more than an induction motor, in which the slip-ring rotor is replaced by a direct-current armature, with brushes arranged on its commutator in such a way as to divide the winding into a number of stationary symmetrically spaced phases coupled in mesh fashion. When the stator is under pressure, the voltage between brushes is produced by the revolving flux, its magnitude being fixed by the relative speed at which the rotor conductors cut this flux ; that is by the slip speed. But its frequency is always equal to the supply frequency. This is the feature which is characteristic of the motor, and which is responsible for making it suitable for variable speed control and high power factor.

To understand this motor in its physical aspect, and neglecting secondary phenomena, its leading properties can be simply stated, as follows :—(*a*) The revolving field on an induction motor is constant as it must produce an electromotive force to balance the supply voltage, which is also constant ; (*b*) this revolving field is produced by the resultant of stator and rotor magneto-motive forces revolving in space at the same speed ; (*c*) the rotor currents are produced by the revolving flux in the same way as in an ordinary generator, and the torque driving the rotor is the torque which any generator offers to its drive ; (*d*) as the electromotive force of the rotor is proportional to the difference of the revolving flux speed and its own speed (slip speed), the electrical power generated by the rotor is proportional to the slip speed, while the mechanical power which it transmits is proportional to its actual speed ; (*e*) the constant power, therefore, given by the revolving flux for a certain torque, can be used partly mechanically and partly electrically ; the more electrical power generated, the lower the speed will be ; (*f*) the slip ring induction type can deliver electrical power at varying voltages and frequencies, according to the speed, while the commutator type can deliver electrical power at the supply frequency ; (*g*) the problem of reducing the speed of such a motor, therefore, involves utilising the electrical power given by the rotor.

In a slip-ring motor, such power cannot be utilised by simple means, because of the varying frequencies. In the commutator motor it can be sent back to the line or to the stator by means of transformers or similar devices, which provide a suitable varying voltage across the brushes. Balancing as it does the rotor electromotive force, this voltage fixes the slip and speed of the motor. Below synchronism, the rotor supplies power to the network. (*h*) If the voltage applied to the rotor changes sign the rotor electromotive force must also change sign ; that is, the motor will run above synchronism and will absorb power from both stator and rotor. (*i*) Being a "doubly fed" machine, it is possible to supply the necessary magnetising ampère turns from the rotor, this being more convenient for speeds not too far from synchronism on account of the small wattless power required. By this means the motor can be made to have a high power factor, or even to give a leading current. (*j*) If the rotor is fed with a varying voltage in phase with the supply and the brushes are moved backward or forward, the rotor electromotive force will lead or lag on the electromotive force opposing the voltage. In the former case the voltage would therefore have a magnetising component relieving the stator from its duty of providing the magnetising current or even obliging it to have a leading current, and thus act as a condenser on the network. Above synchronism, the same effect is obtained by moving the brushes forward.

These are briefly the leading features of a commutator shunt motor for variable speed drive. The following are characteristic curves of an 18 brake horse-power, three-phase, 50-cycle 400-volt motor running at 475/1400 revolutions per minute, made by the Electro Dynamic Construction Company, Ltd. The motor gives constant torque throughout the speed range corresponding to 18 brake horse-power at 1400 revolutions per minute. The motor is started by means of an ordinary resistance three-phase



CHARACTERISTIC CURVES OF COMMUTATOR SHUNT MOTOR

starter, and can exert its full load torque by taking $1\frac{1}{4}$ times the full load current from the line.

The speed controller consists of a special inductive regulator, which acts as a medium for transference of power between the rotor and the stator windings. This allows the motor to take approximately the same current at all speeds when giving the same power. When giving the same torque at different speeds, the current taken varies approximately in proportion to the speed.

From the curves, it will be seen that above synchronism—750 revolutions per minute—the current becomes leading, the motor thus acting as a condenser on the line. When the motor is running light, it can deliver a leading current which can be as great as 30 of its full load current. This feature is of special interest to the supply engineer who has to deal, generally, with large wattless lagging currents which load the network and generating plants and for which no charge is made.

THE BIRTHDAY HONOURS.

IN the list of Birthday Honours, which was issued on Wednesday last, appear the names of Mr. Hugo Hirst, the chairman of the General Electric Company, Ltd., and member of the Board of Trade Advisory Council, and of Lieut.-Colonel James Lithgow, M.C., D.L., of the firm of Lithgows, Ltd., Port Glasgow, and President of the National Confederation of Employers' Organisations, who have been created baronets.

A knighthood has been conferred on Mr. C. D. M. Hindley, the Chief Commissioner of the Indian Railway Board, and a Companionship in the Order of the Indian Empire for Mr. C. W. Lloyd Jones. The latter is the agent and chief engineer of the Nizam's Railway, and has of late been particularly known to railway engineers in this country and in the United States because of his work on the Indian Railway Bridge Committee. His experience in the matter of impact in India and the United States was particularly useful here to the Joint Committee of Inspecting Officers of the Ministry of Transport and Railway Engineers, when dealing with impact effect in connection with a revision of the Requirements as to New Railways. Another railway man to receive an honour, that of a knighthood, is Mr. H. E. Blain, for some years assistant managing director of the Underground Railways and their associated companies. Mr. Frederick Thomas Hopkinson, M. Inst. C.E., has been created K.B.E., for services in connection with the Nile Dam, Sudan.

Railway Matters.

IT is announced that the position on the administrative board of the German Railways, made vacant by the death of Sir William Acworth, has been filled by Brigadier-General H. O. Mance.

THE summer train service by the Great Western route to North Devon would ordinarily be brought into use with the other holiday trains on July 13th, but at the request of the local authorities it was begun on June 2nd.

DURING last year 41 passengers were killed, 2125 passengers injured, 216 servants killed, and 1477 servants injured in train accidents in the United States. As showing the comparatively satisfactory character of these figures, it may be said that ten years ago 85 passengers and 452 servants were killed and 7001 passengers and 4823 servants injured. In "movement" accidents 976 servants were killed and 30,697 injured last year as compared with 2071 killed and 46,018 injured in 1914.

WE hear with regret of the death, in his eighty-eighth year, of Mr. James Holden, who was for over twenty years the locomotive, carriage and wagon superintendent of the Great Eastern Railway, from which position he retired in 1907. To most people Mr. Holden will be remembered as the advocate of liquid fuel for locomotives; to others as the builder of the decapod engine. But perhaps his best, though probably least known, work was the standardisation of wagons, both railway—and privately—owned.

MOST of the mineral traffic in England and Wales is carried in wagons that are privately—and not railway—owned. Those wagons do not, however, always belong to the user but have been hired by him from firms which make a business of letting wagons out on hire. The profits to be made from such a business have recently been revealed in a prospectus issued by a wagon-hiring firm. It shows that the profits made during the last five years are sufficient to cover the preference dividends more than four times, and, after deducting the preference dividends, to leave an amount equal to 10¼ per cent. on the ordinary shares.

THERE now appears to be a distinct tendency in America to employ electric locomotives which enable high-pressure alternating-current to be drawn from a single overhead wire. The Great Northern Railway Company of America has just placed an order with the American Westinghouse Electric and Manufacturing Company for four engines and other equipment to be used in connection with the electrification of its Cascade Mountain Section, extending from Skykomish at sea level, through the Cascade Tunnel to the summit, an undertaking which will be completed in a period of ten months. The engines are to be equipped with motor generators, which will convert the high-pressure alternating-current collected from the overhead wire into direct-current for driving the motors, in accordance with the scheme adopted on the Detroit, Toledo, and Ironton Railroad—see THE ENGINEER of March 20th, 1925. Hydro-electric power will be used for working the line, and in view of the large amount of water power available in the Pacific North-West, this undertaking, it is said, may be regarded as the beginning of a large electrification project.

TUESDAY next, June 9th, will be the Jubilee of the opening of the Newark brake trials. They were conducted by the Royal Commission of 1874 on Railway Accidents, of which the Duke of Buckingham and Chandos was the chairman. The site was on the Midland Railway between Newark and Lowdham, on the Nottingham and Lincoln branch. Trains were provided as follows:—London and North-Westerm, with Clark and Webb's chain brake; Great Northern, with Smith's vacuum brake; Midland with Westinghouse air brake; Midland with Clark's hydraulic brake; Midland with Barker's hydraulic brake; Lancashire and Yorkshire with Fay's brake; Caledonian with Steel-McInness air brake; London, Brighton and South Coast with Westinghouse vacuum brake. The North-Eastern provided an engine only, fitted with Smith's vacuum brake. The trials lasted six consecutive working days and 70 runs in all were made, of which 14 was the highest number for any one day. They were carried out for the Commission by Mr. Edward Woods and Colonel Inglis, who were assisted by Lieutenant R. G. Scott and Lieutenant M. H. P. Riall Sankey. The results were not made known until the report of the Royal Commission on the whole subject of railway accidents appeared in February, 1877. Those who expected that judgment as to the merits of the various systems would be pronounced were disappointed, as the report observed: "We think it would be neither fair nor desirable at present to pronounce definitely either for or against any particular invention brought before the Royal Commission."

IN the recent debate on the Vote for the Ministry of Transport, Colonel Ashley, speaking of the remarkable safety of British railways, said that "it was a tribute to the administration of the railways, and, above all, to the working staff, that the general public were carried so safely and so swiftly." Proceeding, the Minister said that, whatever the reason was, electrification was not making the progress he should like, except on the Southern line. The Southern Railway, with considerable enterprise and in the face of the difficulties of amalgamation, which were especially acute, had in execution a very substantial programme of electrification which, he understood, would be completed by the end of July. Sir Robert Horne, who, it should be remembered, is a Great Western director, speaking later, denied that the railways were slow in considering the advantages that might be derived from electric power. He happened to know of one great railway from the inside, and he believed that what was true of it was true of the others, viz., that they were striving to discover means whereby they could reduce the cost of transport, particularly by the use of electric power. Sir Henry Jackson, speaking as a member of the Advisory Committee on London Traffic, said it was the Committee's intention to inquire very closely into new tubes for the North-East and North of London, the South-East of London, and East London. The Minister had recently set up a sub-committee of the Advisory Committee, which would meet almost immediately, to consider these three great new tubes. They would hold a public inquiry and take evidence.

Notes and Memoranda.

DURING the official trials of the new L.M.S. turbine steamer Glen Sannox, which was built by Wm. Denny Brothers, and started on the Ardrossan–Arran run on Whit Monday, a mean speed on the double run between the Cloch and Cumbrae Lights of 20.75 knots was recorded. The actual mean speed of the vessel through the water was 21.15 knots.

AS a fireproofing medium, one part by weight of selenium, according to *Industrial and Engineering Chemistry*, protects 3.6 parts of cotton braid and 10 parts of rubber covering in the presence of 10 parts of copper conductor, constituting the usual No. 22 switchboard wire. Three milligrams of selenium thus protect a centimetre of length of wire, or one pound protects nearly a mile. The protection referred to is freedom from spreading of the flame along the wire held horizontally when the Bunsen burner, candle, or other igniting agent is removed.

THE two largest zinc mines in China are at Shuikowshan, Hunan, and Tungchwan, Yunnan. The former once produced as much as 26,000 tons of zinc ore in one year, but has not been fully operated, because there has not been much demand from foreign sources, nor much chance of smelting the ore in the country. It was formerly owned by the Government, but is now under private management. The ore from this mine can be transported by the Canton-Hankow Railway from Changsha to Hankow and thence by boat to Shanghai.

ACCORDING to engineers of the Department of Marine and Fisheries, Ottawa, the situation created by the lowering of the water levels of the Great Lakes is becoming increasingly serious. The water of Lake Superior in March was 3in. lower than a year ago, and 10½in. lower than the average level of the lake during the past ten years. Lake Huron was 4in. lower last month than in March a year ago, and 1ft. lower than the average for the past ten years. Cargoes on the Great Lakes will be approximately one-thirty-eighth less than a year ago.

IT is claimed that by means of the Hoope electrolytical process aluminium with a purity of 99.983 per cent. has been obtained. The principal impurity is usually copper, iron and silicon being present in very small amounts only. This high purity greatly increases the resistance of the metal to chemical reagents, especially to acids. While a piece of ordinary 99 per cent. aluminium sheet, immersed in a test tube of dilute hydrochloric acid, will dissolve completely in a few days, the high purity metal is only slightly affected after a week's immersion. The metal is also much softer than ordinary aluminium, and holds its lustre in the air almost indefinitely.

ACCORDING to Mr. E. E. Thum, in the *Iron Trade Review*, many experiments have shown that the heat effect of an oxy-acetylene cut seldom is more than ½in. deep. Even in the case of a 6in. billet the depth of the heat effect is quite uniform from the top to about ½in. from the bottom, where it extends somewhat more deeply into the metal, owing to the fact that globules of metal and molten slag drip from the under side of the slab. Experiments also showed that a surface cut by the oxy-acetylene torch is somewhat harder and stiffer than the original metal, but has excellent ductility. Such a surface is apparently the equal, if not the superior, of a milled surface in physical properties.

GILSONITE, asphalt, cumarin resin and ordinary rosin are used, including usually 20 to 50 per cent. of the resinous constituent, according to *Chemical and Metallurgical Engineering*, for coating the interiors of acid tanks. They are melted together in a metal tub, then applied with a broom to the cleaned inner tank surface, leaving a rough coating about one-sixteenth of an inch thick. The seams are usually filled with a special coat of the same or similar material previous to the overall treatment. To an iron pipe, light enough to be readily handled, a flexible connection is made to a gas main. A man working inside the tank, beginning at the top slowly moves this improvised torch around flowing the coat on smoothly and evenly. The finished job is said to be decidedly superior to that which can be obtained by means of a swabbing operation only.

MAGNESIUM oxychloride is, according to the *Chemical Trade Journal*, almost unique in its ability to bind woody or fibrous material into a firm, compact mass, and in this *rôle* it finds very extensive use as a composite flooring for the interior of buildings where absolute sanitation and cleanliness are essential. As such it has been used in laboratories for the manufacture of fine chemicals and pharmaceutical products, in modern offices and public buildings, and in hospitals and laundries. It is considerably less expensive than marble, slate, mosaic tile, or terazzo, and even compares favourably with hardwoods. The floors are dustless, very resistant to abrasion, and have high tensile strength and unusual resilience when mixed with an appropriate filler. They are capable of taking a good polished surface, but are not slippery, and, in addition, they are found to be comparatively warm.

AN electric generating station with an ultimate capacity of 700,000 kilowatts, is to be erected by the New York Edison Company. In the first place, states the *Electrical World*, the station will have a capacity of 120,000 kilowatts, but at a later date the capacity will be increased to 700,000 kilowatts. Buildings to house the initial installation will cover an area of about 73,130 square feet. The first part of the plant to be installed will consist of two 60,000-kilowatt 25-cycle 11,400-volt General Electric turbo generators, a 40,000-kilowatt 25–60 cycle frequency charger, and ten Springfield water-tube boilers, equipped for burning pulverised coal. The boilers will be designed to work at a pressure of 375 lb. per square inch, and to supply steam to the turbines at a temperature of 700 deg. Fah. All the main auxiliaries will be steam driven. When the station is extended, mercury vapour turbines and boilers may be installed, but the exact size of these units has not yet been settled. Some more 60,000-kilowatt steam units or even larger units are, however, contemplated, and it is probable that another 40,000-kilowatt frequency charger will be put into use, when a demand for a greater interchange of power occurs. The new station will be interconnected with the 25-cycle system of the Edison companies by underground cables working at a pressure of 11,400 volts.

Miscellanea.

THE exports of New Caledonia in 1924 included 125 metric tons of nickel ore, 15,292 tons of chromite, and 4781 tons of nickel matte.

BETWEEN 8000 and 9000 tons of coal are being mined daily now in the mines of the Crow's Nest Pass, Alberta. At the Fernie mines the daily output is approximately 3000 tons.

IN a report to the Sydney, New South Wales, City Council Mr. Forbes Mackay recommends that the council's new power-house should be erected on a site, previously suggested, at Botany.

THE manager of the Victorian State Coal Mine at Wonthaggi estimates that 21,451,058 tons of coal still remain in the mine. In the year 1923–24 approximately 500,000 tons were mined.

WORK was started on the construction of the new reservoir for the Birmingham water supply at Bartley Green on May 26th. The two new triple-expansion pumping engines at Edgbaston were also started on that date.

THE South African coal output for March (1,109,642 tons) is the largest for over twelve months, but its value at the pit's mouth (£333,786) is £8000 less than that of the output for October last, when 1,100,622 tons were produced.

THE new generating station for Capetown and the surrounding electrified railway lines is to have an initial capacity of 30,000 kilowatts. It will be erected on a site of some 40 acres on the north side of the estuary of the Salt River.

AN agreement has been entered into between the Russian Soviet Government and a British firm for the erection of an oil cracking factory at Baku, to be used for the conversion of the thick oil in its natural state into benzine by a new thermal process.

IT has been agreed that the Australian Sugar Producers' Association and the United Cane Growers' Association be asked to co-operate in the engaging of the services of three qualified experts to inquire into the question of manufacture of power alcohol from sugar cane and molasses.

RHODESIA continues to maintain its position as the leading producer of chrome iron ore in the world. The output for 1923 was 96,675 tons, and for the first eleven months of 1924 production was over 157,500 tons. The most important productive areas in Southern Rhodesia are those in the Selukwe area of Matabeleland.

THE Administration of the Egyptian State Railways will shortly be inviting tenders for several new bridges. Among them there will be an opening span at Abou-el-Akhdar, to carry the two tracks of the Cairo-Port Said line; another for spanning the Mahmoudia Canal at Alexandria, and a third over the Bahr Youssifi at Sandafa.

IT has been decided to establish the most northerly main station of the North-West Territories and Yukon wireless system at Aklavik in the Mackenzie River delta. Aklavik is more than 2000 miles north of Edmonton by the regularly travelled routes and is the terminal of the Mackenzie River navigation and the northern winter mail service.

A SIXTH seismograph station, which will assist in the work of those maintained at Saskatoon, Halifax, and Ottawa by the Dominion Observatory and at Victoria and Toronto by the Meteorological Service, has been established at Ste. Anne de la Pocatière, Quebec, by the Department of the Interior. The new station is situated near the centre of the area affected by the earthquake of February 28th.

A HISTORICAL model exhibition in the field of water power and pumping, covering the period from the fifteenth to the eighteenth century, was displayed by the City of Augsburg, Germany, at the recent annual meeting of the Verein deutscher Ingenieure. Records indicate that mills driven by water power existed in Augsburg as early as the eleventh century, and six were in operation in the year 1276, this number increasing tenfold in the following five years.

DESIGN sketches of the experimental arch dam which is to be built on Stevenson Creek, in Southern California, by the Committee on Arch Dam Investigation of Engineering Foundation have, according to the *Engineering News-Record*, just been made available. It is intended to build the dam ultimately 100ft. high, but the first test will be made at 60ft. height. Of the total fund of 100,000 dollars, about two-thirds have been subscribed, which is sufficient to build and test the 60ft. dam; the remainder is required for the construction to full final height.

THE South Australian Government has engaged Dr. Hyman Herman to investigate and report upon the possibilities of utilising the brown coal deposits at Moorlands, South Australia. The lease of the land, formerly held by the Tailem Bend and Murray Coal Company, has now reverted to the Crown. An area of 73 square miles has been reserved, and the Government has put down eighty-five bore-holes. The average thickness of brown coal is 14.8ft. and the average depth from the surface 79ft. The total area so far proved by boring is 389 acres, and the brown coal available is estimated at over 8,000,000 tons.

AT the annual general meeting of the Institute of Physics, held on May 25th, Sir William Bragg was elected president in the place of Sir Charles Parsons, whose term of office expires on September 30th next. Major C. E. S. Phillips was elected to succeed Sir Robert Hadfield as treasurer. The remaining offices were filled as follows:—Past-presidents: Sir R. T. Glazebrook, Sir J. J. Thomson, Sir Charles Parsons; vice-presidents: Professor C. L. Fortescue, Dr. E. H. Rayner, Sir Napier Shaw, Mr. R. S. Whipple; hon. secretary, Professor A. W. Porter. The annual report gives the total membership as 515, which includes 293 fellows and 135 associates. There is stated to be unlimited scope for further applications of physics in the arts, industries and public services, and therefore for the increased employment of highly qualified physicists, and during the past year there has been a fair demand for young honours graduates in physics with two or three years' research experience.

OIL-DRIVEN PUMPING PLANT AT CHIPSTEAD, SURREY

CROSSLEY BROTHERS, LIMITED, MANCHESTER, ENGINEERS

(*For description see page 632*)

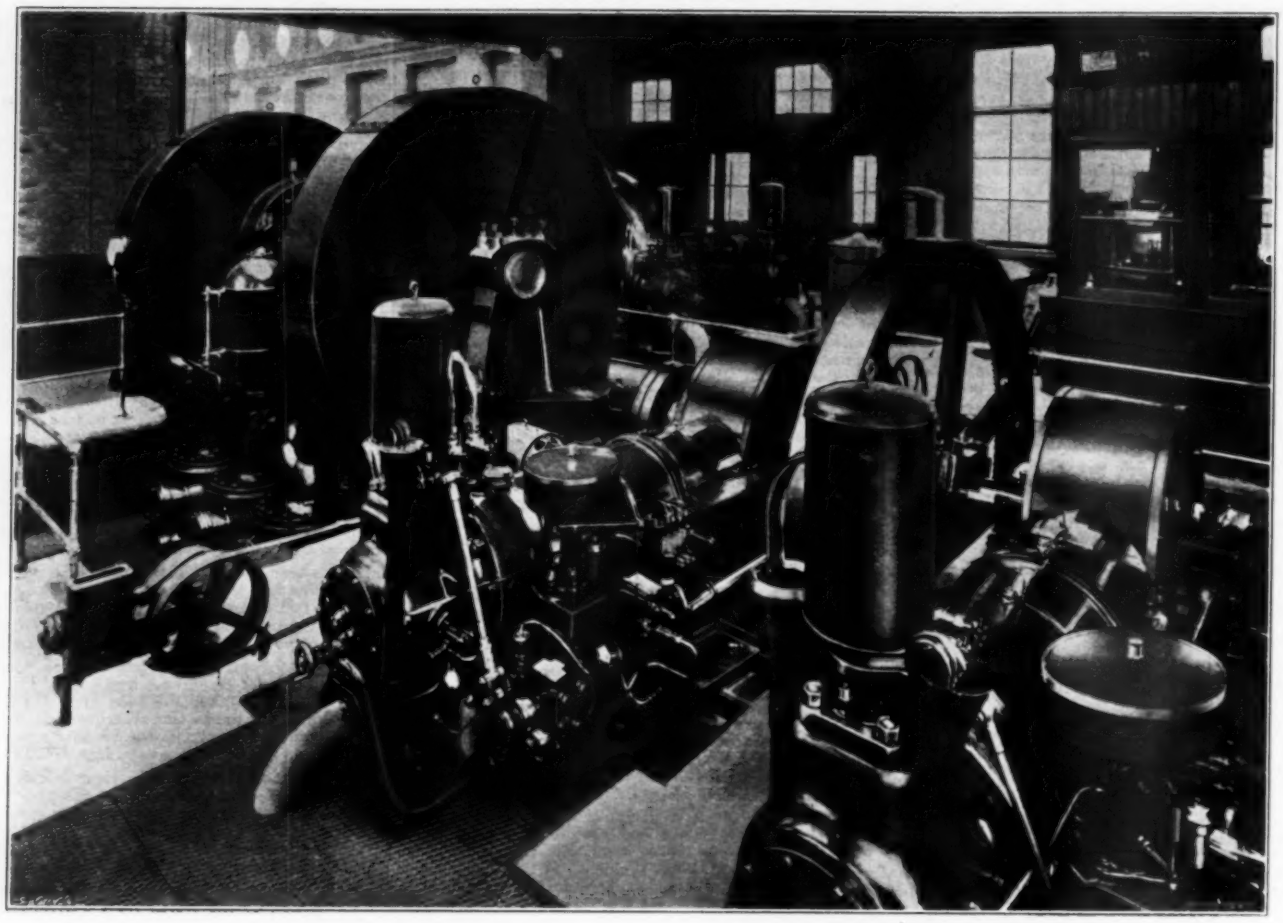


FIG. 1—ENGINE DRIVING HIGH-LIFT PUMP THROUGH GEARING

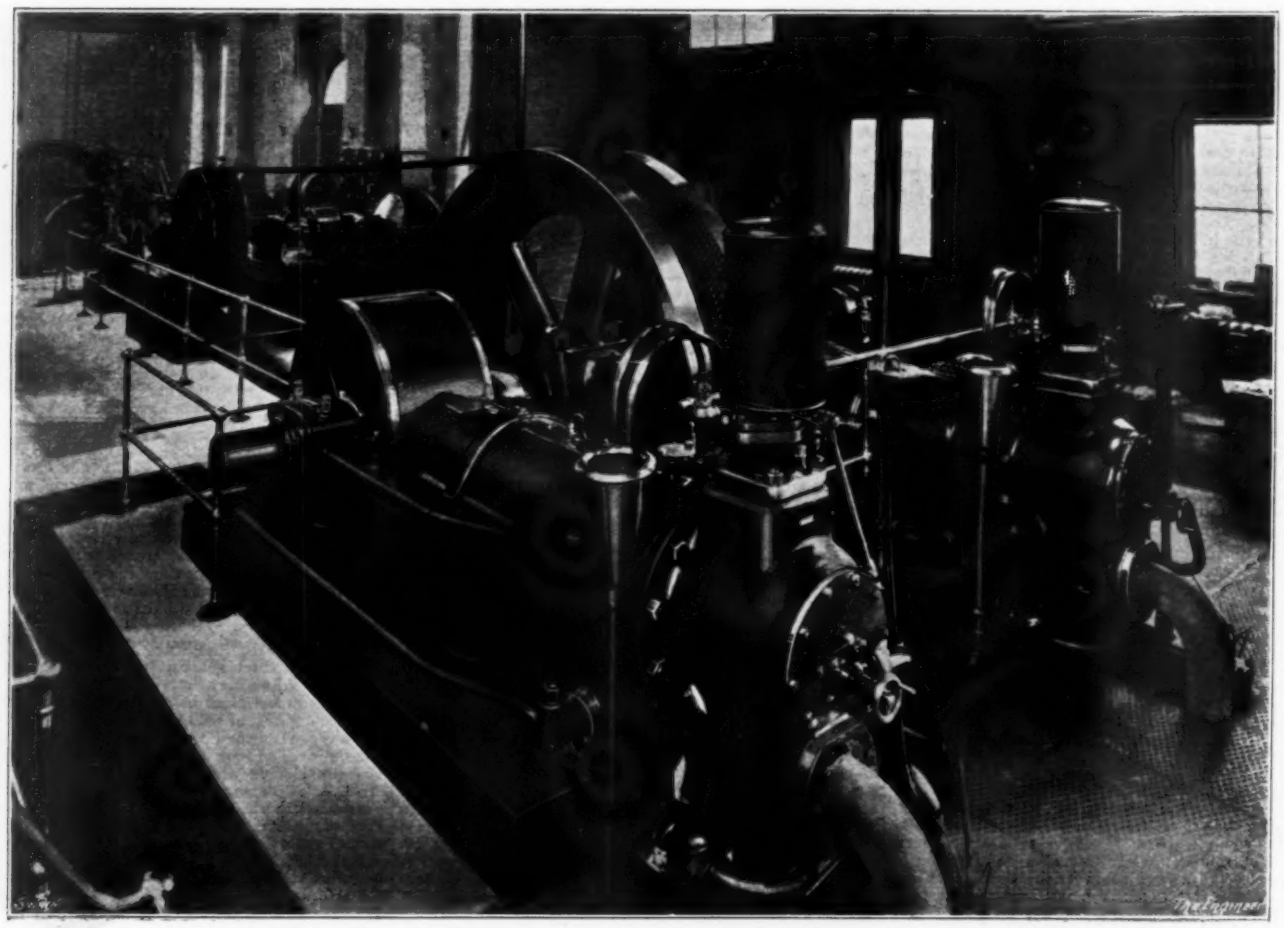


FIG. 2—ENGINE DRIVING TURBO-PUMPS THROUGH ROPES

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THE ENGINEER.

JUNE 5, 1925.

The Exchange Trials of Locomotives.

WE are surprised that an analytical report of the exchange trials of Great Western and Great Northern express locomotives has been published by the Great Western Railway. We had been given to understand that if any account of the runs was issued it would be prepared conjointly by the engineers of the two companies. The article in the *Great Western Railway Magazine* is quite plainly not a scientific examination of the data. The Great Western is justifiably proud of its engines, which did splendid work, better even than was anticipated, but the manner of presenting their merits lowers the trial from the level of a technical inquiry to that of a mere competition. We have from the first failed to see that any useful conclusions could be reached through the tests, but if anything of value does reside in them it is only to be extracted by a careful examination of many facts besides those which are given by the records. It must never be forgotten that each locomotive was built for its own road, for its own service, for its own coal, for its own conditions. To change them about was not fair to either, but conceivably it might be fairer to one than to the other. We can imagine that had Mr. Collett to design an engine for the Great Northern, he would produce such a type as Mr. Gresley's "Pacific"; equally, we can imagine that if Mr. Gresley were designing for the Cornish Riviera express and the Great Western road, he would turn out something not unlike the "Castle" class.

In considering the official report presented by the Great Western Railway, the figures in which may, of course, be accepted without reserve, we would disregard all those that refer to the speeds attained. They are, we believe, wholly without significance. In the consecutive runs on the Great Western Railway the Great Western drivers paid little attention to the statutory speed limits. The Great Northern driver was more precise; he followed the instructions of the Great Western inspector who rode on the foot-plate, and, as the detailed returns show, kept closely to the scheduled times throughout. It must be remembered that, apart from preliminary runs, the driver and fireman only made three trips in the down direction and three up. With a little more experience of the road, which as to one-half or thereabouts is distinctly difficult, it is probable that they would have run a good deal faster, but it cannot be said that the type of engine is suited to the line. Even the Great Western itself never found its own "Pacific," the Great Bear, satisfactory. Furthermore, the permanent way of the Great Western is not as good as that of the Great Northern, and the driver of Mr. Gresley's engine would not face the speeds to which the Great Western drivers are accustomed. When we turn from the runs on the Great Western to those on the Great Northern, the greatest amount by which Mr. Collett's engine exceeded schedule speed was four minutes between Grantham and King's Cross. Its average saving of time for five trips was two minutes, enough to show that it could keep to schedule time with the trains, but not that it could run away with them. But it is waste of labour to discuss times of arrival without knowing the whole details of each trip. For instance, it must be observed that, since the Great Northern engine would not make the high speeds on the down gradients of the Great Western which the home engine made, it must have taken the banks at a fast rate. It is reported that on one occasion it topped the summit at Savernake at 64½ miles per hour. Until the detail figures are before us, we cannot say that the Great Western engines were capable of a similar effort. We know, however, that the Great Western engine did pull the trains out of King's Cross up to Finsbury Park in admirable fashion, from which it is evident that the class is capable of making short, sharp climbs with heavy loads. Here it is necessary to make one point quite clear. The *Great Western Railway Magazine* gives the weight of Mr. Gresley's engine as nearly 29 tons more than Mr. Collett's engine. That is not quite correct. Engine for engine, the former is only about 12 tons heavier than the latter. The main difference is in the tenders, and enforces, in a striking way, what we have said about the suitability of each engine for its own service. The Great Northern engine is designed to run from York to Edinburgh and back. For that reason it is provided with a very big tender, which will carry 5000 gallons of water and no less than 8 tons of coal. Let us now consider the question of coal consumption. Everyone who is familiar with the running statistics of locomotives is aware that considerable variations exist between engines of the same class and between drivers. An engine tuned up may show an advantage of several pounds over an engine which is in less perfect condition. Now, it will be recalled that on the first day—April 27th—of the tests the Flying Fox ran hot, and the runs on the Great Northern were cancelled. On the following day the Great Northern put on another engine, but one that had not been especially prepared for the contest. The figures given by the *Great Western Railway Magazine* show that it consumed 57.1 lb. per train mile, as against the 53.4 lb. of the Great Western engine. Now it so happens that the average consumption of the "Pacifics" over long periods is much nearer 52 lb. per mile than 57 lb., so that the figure is not truly representative. On its own road the Great Western engine consumed on an average of six runs 41.9 lb. per mile against 47.9 lb. by the Great Northern engine, which probably indicates that the shallow fire-box of the Pacifics—which suits a thin fire of Yorkshire coal—is less suited for Welsh coal—which requires a much thicker fire—than the Great Western box is for Yorkshire coal. It is worth observing that the coal consumption of the Great Northern engine on the Great Western road declined as the trials proceeded. We quote the figures from the official records. April 27th (down), 50 lb.; April 28th (up), 50.9 lb.; April 29th (down), 48.8 lb.; April 30th (up), 45.2 lb.; May 1st (down), 52.4 lb. (exceptional adverse wind); May 2nd (up), 40.4 lb. These data show that with still further experience of the Welsh coal, the Great Northern engine would have approached, even with an unsuitable box, the lowest figure of 36.8 lb. attained by the Great Western engine.

What we have written may appear as a defence of Mr. Gresley's engine. In a sense, we admit that it is so, for we cannot but feel some resentment that trials of this kind should be used for advertisement. But far more than a defence of the "Pacifics," it is a condemnation of the tests themselves as a whole. It is as certain as anything could be that no truly comparable figures could be obtained in five or six trips of each engine. A variety of circumstances may have intruded to vitiate the comparisons and inevitably many important factors could not be taken into account. We have already pointed to the difference in the design of tenders necessitated by the different services for which the engines are designed. We might also refer to the difference in boilers. Assuming some figures, we make the boiler horse-power of Mr. Collett's engine 1400 for a cylinder horse-power of 2080; whilst Mr. Gresley's boiler has a horse-power of 1815 for a cylinder horse-power of 1946. Mr. Gresley has found that this great boiler horse-power is necessary for his service; Mr. Collett is content with less. For that reason and because he is using 225 lb. pressure, his mainten-

ance charges are almost certainly higher than those of Mr. Gresley. That is a very important point, which has to be studied when comparing the merits of respective locomotives, and it cannot be ascertained in a week's run of four engines. Hence, we come back to our old position that such contests have no scientific value. At the same time, it is not improbable that the inspectors who ran on the "foreign" engines were able to make useful observations, and it may be suggested that in the general interest of locomotive engineering it would be a good thing if an exchange of the kind became general. It is well known, for example, that on some lines engines are always driven notched-up with the regulator full open. Dugald Drummond always insisted on that practice, and we believe it is followed on the Great Western. There is no question that it is the right practice, and if travelling inspectors or even drivers themselves could see it in use, its employment would become more common. Then, again, there are many technical points which could best be seer by the observation of inspectors on the footplate. Such an exchange of courtesies may be one of the few good things that come out of such tests as those with which we have dealt.

Vibration.

IT is conceivable that if the brilliant satirist who wrote "Penguin Island" had completed that work in 1925 instead of sixteen years earlier, a new terror would have been added to those recited in his forecast of life in the giant town in which fifteen million were to labour. M. Anatole France might then have seized upon the twin factors of noise and vibration and have commented at length upon the fact that the greater daily stress of modern existence reacts not only upon the inanimate structure, but upon animate beings. The nerve-wracked human machine, enduring—or trying to endure—an environment which our less civilised ancestors had not to face, suffers from its environment in a manner which has its parallel in the destructive forces that threaten both the artistic triumphs of which all are proud and the purely utilitarian structures of less æsthetic merit. Metal structures, to take one example, are more prone to corrosion in the atmosphere of our large cities than in country air, and with all the assistance of our ally, the chemist, fortified by knowledge which our ancestors neither possessed nor missed, the engineer and the architect cannot hope for the same life of ordinary mild steel structures as that of about 2800 years ascribed to the iron "Laht" of Delhi. Furthermore, when we turn to structures of stone and cement, we see that the activity to-day of an acid-laden atmosphere in industrial areas is accelerating the decay of certain stones at a pace which would have astonished the architects even of the eighteenth century.

The intensity of industrial activity and of scientific effort have not, in all cases, left us without palliatives; indeed, in some respects we are perhaps better off than those whose materials were wood and stone. But we have our own troubles. With such age-long annoyances as shrinkage and dry rot in timber, or the effect of rain and frost on mortar and cement, or the shifting of foundations through abnormal dryness or flood or gales which may damage our roofs, we have also to-day frequently to reckon with the effect of mechanical vibration on structures of all sorts and kinds, including the human machine. For these effects redress such as the law allows is often sought. In the court of law every vibratory movement which is faintly perceptible becomes an intolerable nuisance to the complainant in the witness box. In this respect, human faculties are are variable as in the other senses of taste, sight and smell, and perfectly truthful rebutting evidence may be obtained if the defence has witnesses whose susceptibility to vibration is below the normal. Yet testimony as to an absolute absence of vibration can have no scientific basis: In every town in which there is vehicular traffic of any sort, or machinery of any kind, vibration is present in greater or less degree. Generally it is so infinitesimal as to be inappreciable, and even too small for measurement by the most sensitive instruments at present available. In passing, let us note that the vibration of buildings and their contents cannot in many cases be divorced from the accompanying phenomena of sound, no matter whether that sound be primary, *i.e.*, produced by the source of the vibratory movement of the structure, or secondary, *i.e.*, produced by the rattling of windows, doors or ornaments at the receiving point. The elimination of primary sound waves and their effect on the observer are a subject by itself; our present concern is wiih the effects of vibration. In any of our own cities and towns any building is liable to injury from the effects of minute oscillatory movements of the soil which conduct mechanical vibrations from their source to the position affected. These movements, because of their analogies with the movements of fluids may be termed earth waves. Comparisons of the effect on human beings of earth waves vary with the product of the linear movement at the point of reception and the number of movements per unit of time. Variations occur in the relative efficiencies of transmission in, and absorption by, different media. That different strata possessing as they do varying degrees of elasticity and compressibility are good or bad transmitters of earth waves is well known, but their relative order has not yet been fully investigated. The effects of variations in the nature of the transmitting medium may be compared to viscosity effects in incompressible materials, such as liquids. Imagine, for example, ponds of equal area and equal depth of quicksilver, water, and heavy mineral oil. It will be recognised that stones of equal weight dropped into the centre of such ponds would produce concentric waves which would take varying times to reach the banks of the pond, depending upon the viscosity of the liquids. In considering the varied strata of the earth's crust, we have to allow for this quality. We have to take into account the molecular friction in elastic solids, and the slow continual yielding (without any great extent of change of shape), together with the coefficient of restitution, say, of stone or cement, which, where the impact is not so violent as to make any sensible permanent indentation in either body, ensures a definite velocity of separation between colliding substances. We have also to recognise the possibility of a recoil wave on one side and the possible causation of another wave on the other side of an ordinary wall. Coefficients of transmission for different soils vary with the material, with the amplitude of the earth waves and with their frequency. Such coefficients have yet to be determined. At present our knowledge seems capable of being summarised only in somewhat sweeping sentences, based on general observation rather than on precise measurement. On the one hand, we may say that a large mass of any of the sandstone rocks in its natural bed is a very poor conductor for the transmission of mechanical vibration. On the other hand, a water-logged alluvial soil transmits mechanical vibration very readily, while clay occupies an intermediate position between a water-logged strata and dry sand, the last-named being the best natural insulator of mechanical vibration that engineers know. The reflection of earth waves from incompressible strata is also probable. Some investigators claim to have evidence of the interception of earth waves from foundations and of reflection from such obstacles as quay walls. Interception must either be accompanied by reflection or by absorption or by both, except where, under conditions of resonance, the intercepting body acts as an amplifier. In many cases the amplitude of the waves must be very small indeed, and, in any uniform medium, diminishes as the distance from the centre of the disturbance increases, with, of course, the formation of intermediate nodal areas and of other intensive areas of intrinsic disturbance. But in the dissipation of vibration earth waves are liable to produce vibrations of very large amplitude in buildings whose natural frequency of oscillation is coincident or nearly coincident with the frequency of the disturbing force, or is a direct multiple of the received frequency. Then arises a resonance effect in the building, which may be further amplified in the furniture, &c. Occasionally cases reach the courts of alleged nuisance from vibration—generally from the operation of moving machinery. Most genuine cases of this kind have as an accompaniment a mechanical resonance effect in the building. The building itself or certain items of furniture have a natural periodicity nearly or exactly coinciding with the frequency of the received vibration. Thence arises an amplification of the received linear movement which may be thirty or forty or even more times as great as that of the received wave. For a time, severe vibration is felt, and its psychological effect is enhanced by the secondary sound waves we have mentioned.

There is another class of vibration trouble which does not yet seem to give employment to judges and juries, and to counsel learned in the law. We cannot recollect any case of a property owner seeking an injunction against the owner of any road vehicles for alleged nuisance and damage to his property, nor asking for an injunction against the local authority concerned to prohibit traffic along any thoroughfare until the road surface has been renewed, though the effect of traffic, both on the surface and beneath it, has been discussed in prominent cases, as, for example, the cracks in St. Paul's Cathedral. It is true that earth waves caused by road traffic are intermittent. Their destructive effect varies not only with the density of the traffic, but with the condition of the road surface, the weight and speed of the vehicles using the road, and the nature of the intervening medium between the road and the foundation of the building. In general, strongly marked resonance does not occur. The effect we have to study is most often that of two successive earth waves produced as, first the leading and then the trailing wheels of a vehicle pass over a single depression or elevation in the road. The wave first received causes or tends to cause any building to start vibrating at its natural frequency. Such oscillations would and do tend to die away. They would, however, be enhanced momentarily if the time interval between the first and second wave were equal to the interval in time between the first and second of the produced oscillations. This, however, is scarcely a true case of resonance. The effects are transitory—the cause covers one or two seconds, the effect perhaps twice as long. It is true they are repetitive, and as water will wear away a stone, so these repeated periods of vibration due to concussion cause fatigue effects in the structure and lead ultimately to serious damage. We are likely to hear a great deal about this resultant damage in the next decade. The ratepayer is taxed in regard to road maintenance; yet if road upkeep is inefficient and vibration results, the property upon which the rates are levied depreciates. In such cases the direct cost of structural repairs to the ratepayer may exceed his annual contribution for several years of road maintenance.

The International Railway Congress.

No. I.

AFTER its fifth session, which was held in London in 1895, the International Railway Congress arranged to meet every five years, and succeeding meetings were held in Paris, Washington and Berne in 1900, 1905 and 1910 respectively. The war led to the abandonment of the proposed Berlin meeting of 1915, and the Congress did not resume its sessions till 1922, in which year it met in Rome. On the invitation of the Spanish Government, it was then decided to meet in Madrid in 1927, but subsequently it was felt that the present year, being the centenary of railways, the gathering should take place in England, and London was selected as the meeting-place. The Spanish Government was willing that its invitation should be postponed until 1930, and the tenth session of the Congress will therefore open in London on Monday, June 22nd.

With such long intervals between the meetings of the Congress, it is desirable that we should again say that its business is conducted by a permanent commission, which selects the subjects that shall be considered at the sessions. The Congress is divided into five sections:—(1) Way and works; (2) locomotives and rolling stock; (3) operation; (4) general; and (5) light railways. Reporters are appointed to prepare reports on these subjects, and these reports are printed some months before the Congress meets, and are debated in the sections, sometimes by two sections jointly. The section concerned draws up its "conclusions" on the reports, and these are considered by a general meeting of the Congress, held towards the close of the session. Usually two, and sometimes three or more, reporters deal with the same subject; one generally takes Great Britain and the British Empire; another reports for America; and a third for the countries on the European Continent. Occasionally, there are joint reporters for the same area.

At the Rome meeting twenty-one subjects were covered by fifty-five reports; this year in London seventeen subjects are to be covered by thirty-four reports. Only two of the latter will be furnished jointly, and therefore there are thirty-six reporters. The reporters' names were given in THE ENGINEER of November 2nd, 1923, and the only change made therein is the substitution of Mr. E. C. Cox, of the Southern Railway, for Sir H. E. Blain, of the Underground, as the colleague of Mr. Arthur R. Cooper, in reporting for America, Great Britain and the British Colonies on Suburban services.

Following our practice at previous sessions, we give a summary of those reports of interest to engineers.

TRACK.

Subject I. A relates to maintenance of the track, and its full title is "Different Methods of Mainten-

ance and Repair of the Track: By the Administration, by Contractors, by Piecework or Premium System. Mechanical Appliances. Comparisons from the Technical and Economical Points of View." Report No. 1 comes from France, and is by M. R. Ruffieux, of the P.L.M. Railway. The author observes that there is now a tendency to group several maintenance gangs into one, and to give them motor trolleys for the conveyance of men and material, so effecting a reduction in the staff. On the Nord some of the smaller lines are maintained entirely by flying squads, and no permanent gangs are employed. It is questioned whether the daily patrol of the track by the ganger is necessary. On the larger lines that work consumes 1500 working days daily. A chaired road may need close inspection, but a road laid with a flat-bottomed rail does not.

Increased importance is being attached to the prevention of rail creep. On the P.L.M. welding the rails to metallic plates has recently been tried. The plates have flanges which are secured by screws to the four or five middle sleepers of each pair of rails. The same railway has dispensed with the bearing plate—called tie-plate in America—which lies between the base of the rail and the sleeper, since it led to rapid wear of the contact surfaces between rail and plate. The increase in the price of wood and its scarcity have decided certain railways, which hitherto have abstained from the practice, to use metal sleepers on lines having an average or small traffic. The ramming or packing of sleepers by mechanical means is not in general use; but the P.L.M. is trying an electrically operated machine. It is considered that the average economic return would be very small, save perhaps on electrified lines, and the Midi proposes to provide its electrically operated lines with equidistant stations to which a portable transformer may be connected in order to supply power to the various gangs.

An apparatus invented by Monsieur Hallade, of the Est Railway, is being much used in France. It consists of pendulums, placed in a compartment, which register on a chart the vertical, lateral, longitudinal and rotative oscillations of vehicles. From these charts defects in the road can be deduced. The comparison of the charts from time to time gives a good idea of the work done by the gangs.

Relaying and re-ballasting are, except on the French State Railway, usually done by contract. Very rarely is what is known in England as single-line working during obstruction employed in France. The work is done between the trains, and slowing down is, in general practice, found to be sufficient. A numerous staff is, however, essential, and that is the chief reason why few of the railways in France do the work with their own men. Contractors, in a big way of business, can supply from 100 to 200 men, which is too large a number for railway companies to concentrate at one point.

Report No. 2 on maintenance of the track comes from America, and was prepared by Mr. G. J. Ray, the chief engineer of the Delaware, Lackawanna and Western Railway. The reporter says that on some important American lines the general repair work is so arranged as to require a general overhauling of one-third or one-quarter of each section every year. Under such a schedule, all the track is overhauled every three or four years, and in consequence the work of raising, re-spacing, re-sleepering, surfacing and ballasting can be performed in the order mentioned. All relaying is done by the company's own forces, but usually with the employment of local men to augment the regular gang. During the years 1920 and 1921 certain railroads let their maintenance work to contractors. The results obtained during those years were satisfactory, and the work done by the contractors was thought to be economical. The limited amount of maintenance work handled in that manner does not warrant definite conclusions. As Mr. Ray does not explain why that new departure was made, it may be advisable to say that the track maintenance men, being employed by contractors, were exempt from agreements made between the railway companies and the men's unions as to rates of pay.

During Federal control of the railroads the usual ten-hour day was displaced by an eight-hour day. More men are now required, but that disadvantage has been met by the use of efficient motor cars, which quickly transport the men to and from their work. These cars have also been found economical for the handling of small material, such as bolts and spikes, and even sleepers have been conveyed short distances by using trailers. The mowing of the grass by the side of the line is accomplished by placing a mowing attachment on a motor car. The most satisfactory types of cars are those having a free running engine; the original type had to be pushed along the track to start the engine and was unsatisfactory and dangerous.

Machines for packing sleepers have so improved that four, eight or twelve tamping tools can now be operated by one compressor. Other work can also be done by compressed air, thereby economising labour. Rails, for instance, may be drilled, holes bored in wood and in sleepers, screw spikes driven, nuts turned up on fish-plate bolts, and rivets cut out or driven on steel work. The cleaning of ballast by machinery has received a good deal of attention from maintenance officers who have to do with stone ballasted track. Many locomotive cranes equipped with clam shell buckets are being used. The ballast is dug out from between the sleepers by hand and is shovelled on to a conveyor belt which carries it to a rotary screen which separates the fine stone and dirt from the thoroughly cleaned ballast, which is taken by another conveyor belt and replaced on the track. As a rule, on well-ballasted main line tracks, mechanical or chemical devices for killing weeds are not economical and such vegetation as grows is removed by hand or destroyed in the regular working of the ballast. A weed-destroying machine is only economical on stretches of track covered with a heavy growth of vegetation.

The reporter for the British Empire, Mr. W. H. Coomber, divisional engineer, Manchester, London, Midland and Scottish Railway, reports that permanent way—plain track only—constructed in accordance with the standard drawings approved by the Committee on Standardisation of Railway Equipment—Permanent Way, Track and Signalling—is now in actual use upon many lines. Plans for the switches and crossings are now undergoing final consideration. Rails are 45ft. and 60ft. long; sleepers, 8ft. 6in. long—6in. shorter than those previously in common use; rails weigh either 95 lb. or 85 lb. per yard. Standard chairs are provided for both rail sections; they have holes for three steel chair screws. Only one pattern of key is employed. The London, Midland and Scottish Railway has adopted the 60ft. rail; the other companies use the 45ft. Granite is looked upon as the best material for ballast, but it can be obtained at an economic price on only a very few lines. Blast-furnace and steel slag is much used where supplies are readily available. Its use is generally avoided in tunnels because, in damp and confined situations, it is considered to increase corrosion of the track. It is not used on the electrified lines of at least one administration on account of certain chemical properties and also because it is considered too retentive of moisture. That opinion is, however, not general, as it is ordinarily laid on other important electrified railways.

British railways use a check rail on curves of less than 10 chains radius to strengthen the track, but the generally recognised purpose is to safeguard rolling stock against derailment. On the Great Central section the use of a check rail is extended to curves of under 20 chains radius, and, furthermore, where the curve is of 30 chains radius or less the joints of the running rails are staggered. The check rail gap has, in the past, varied from 1⅞in. to 2¼in. The standard design allows a gap of 2in. only, which ensures that the wheel flange shall press against the check rail. The check rail thereby assists in taking the outward thrust on the track and shares the side wear otherwise wholly taken by the outer rail of the curve.

Practically nothing has been done on British railways to prevent rail creep. The tendency seems to be to rely upon a carefully designed chair jaw and a hardwood key. It has been found that a teak key of, say, 6in. length, with its side, top and bottom fitting tightly to the rail and held by a serrated chair jaw, is effective.

On the subject of methods of lengthening the life of the component parts of the track mention is made of the annual lubrication of the fished rail joints. That practice was introduced some years ago and the replies to the reporter's inquiries show that it has lately become very generally adopted. When the bearing surface on the rails on the North-Eastern section has become so worn as to cause ordinary fish-plates to have little or no grip it has been found that a "maintenance" fish-plate—slightly greater in depth than the normal fish-plate—has materially reduced the wear and tear on the sleepers and fastenings at and close to the joint. On the Metropolitan District Railway the rails are particularly subject to uneven wear or "battering." Rails, so worn, are taken up and machined to give an even surface on the top and then replaced in the track. By that means an increased life of about 100 per cent. is secured, whilst the approximate cost of machining is only 10s. per ton. As a means of prolonging the efficient life of stone ballast mention may be made of the practice of regularly screening the ballast, which is lifted from the track, freed from accumulated dirt, sand, or engine ashes, and replaced.

Special self-propelled vehicles, either for moving lengthsmen or special gangs about the section or for systematic examination of the track by inspectors, are very rarely used on British railways. A branch line, 8 miles 7½ chains long and double throughout, on a British railway is now being treated as a single section. The ordinary trains stop to set down or pick up the men as required, and instead of there being four gangs with a total of eighteen men there is now one gang of ten men and four gangers to "walk" the line and to clean switches. Another branch, 15½ miles long, all single track, is maintained by one gang of thirteen men. One man ranks as ganger instead of three. The saving effected amounts to £300 a year and the experiment has proved satisfactory.

There are three methods of carrying out renewals of the track:—(1) Complete removal of old track, followed by the laying of new track to replace it; (2) fitting up of new track alongside or interlaced with old track; (3) re-railing old track and re-sleepering the old rails. The general opinion is that the first method is the most efficient and economical under ordinary conditions. On the majority of lines the actual taking up of the old road and laying the new is carried out on Sundays, but the removal of the ballast from between the sleepers and some other preliminary work is done previously on week-days. There is a growing tendency to seek means by which more of that work may be done on week-days, but it is found almost impossible on some of the more congested lines. The general opinion is that week-day relaying is less costly than Sunday relaying, provided that intervals between the passage of trains are sufficiently long to permit of a considerable length being laid at each break of the track.

A reason that may be advanced for the little use of mechanical appliances on British railways is that the demand for smooth and safe working of a busy traffic, with the least possible interruption, makes a comparatively large working staff necessary to allow for a high standard of maintenance, thorough patrol, and to deal quickly with emergencies. A fairly large supply of manual labour has therefore to be available, and the capital outlay on machinery cannot always be justified. There is also a strong objection to the use of any appliance which, when in work, has to be fixed in such a position as to foul a running line. Mechanical packing has been given a trial on the Great Eastern section, but the results have not justified its general adoption.

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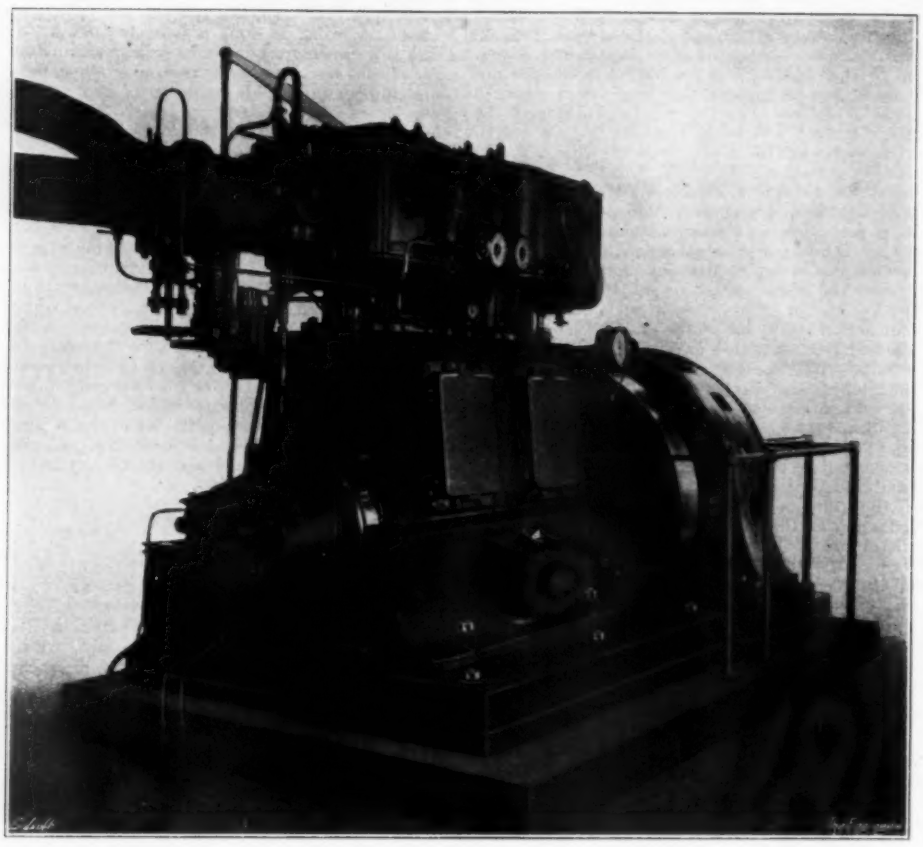
200 K.W. STEAM-EXTRACTION GENERATOR SET

ASHWORTH AND PARKER, BURY, LANCS., ENGINEERS



200 K.W. Steam-Extraction Generator Set.

IT is being increasingly recognised that a considerable economy is possible where power can be obtained from steam prior to its use for heating purposes. In schemes of this nature it is usual to generate the steam at a comparatively high pressure, pass it through a steam engine or turbine developing power, and, when exhausted at a suitable pressure, to utilise it in the heating processes. The principal difficulties met with are, first, an irregular demand for the low-pressure steam ; and secondly, in the case of reciprocating engines, the contamination of the steam by the lubricating oil used in the cylinders.

An interesting example of an engine designed for this class of operation—which we illustrate—is that of a 200-kilowatt generator set supplied by Messrs. Ashworth and Parker, Riverside Works, Bury, Lancashire, through their South African agents, Sturrock (South Africa,) Ltd., for the municipal abattoirs at Johannesburg. In the working of the abattoirs a considerable amount of power is used, while at the same time steam is required for scalding and boiling purposes. The steam pressure at the boilers is 160 lb. per square inch. For scalding a temperature of over 300 deg. Fah. is required and a steam supply of at least 60 lb. gauge pressure is necessary. In addition, a smaller quantity of steam is used at a lower pressure. Both these supplies are used irregularly, but as the power has to be available at any time the conditions are somewhat difficult. In the engine supplied by Messrs. Ashworth and Parker—which might be termed an extraction engine—they have been met in the following manner. The engine is compound, but with a much larger high-pressure cylinder than usual. This cylinder is fitted with expansion gear to the piston valve in addition to the usual throttle control. The dimensions are, high-pressure cylinder 16in., low-pressure 22in. by 8in. stroke, speed 428 revolutions per minute. Between the receiver into which the high-pressure cylinder exhausts and the low-pressure cylinder, is placed another throttle valve under the dual control of the receiver pressure and the engine governor, the latter being able to override the former. From the receiver the supply of steam at 60 lb. pressure is taken, and the function of the throttle valve is to maintain this pressure in the receiver—plus an amount of, say, 10 lb. to cover pipe friction, &c.—whatever the load on the engine may be. Figs. 1 and 3 are front and rear views of the engine, and sectional details are given in Figs. 2, 4, 5 and 6.

The receiver control operates as follows :—The receiver throttle valve A—Fig. 4—is of the double beat-type balanced according to the system patented by Mr. F. O. L. Chorlton. On the actuating spindle rides a floating lever, the left-hand end of which is connected to an oil servo-motor cylinder B. The piston of this cylinder is raised on the admission of oil under pressure—supplied from the forced lubrication system of the engine—and lowered by a spring above it on the release of the oil, the control of the admission and the corresponding release of the oil being decided by the position of a small piston valve C in a chamber attached to the cylinder. The position of this piston valve is in turn decided by the receiver pressure as opposed to a spring above the valve, the compression of which may be varied by a screw adjustment at the top, so as to bring the valve into action at any desired pressure of the receiver.

To the other end of the floating lever is coupled a vertical rod connected to a small excentric mounted upon a horizontal lay shaft above the main oil servo motor D operating the high-pressure expansion gear. This shaft is turned by means of bevel wheel sectors coupling it to the semi-rotary piston of the servo motor, which will be described later. The latter is under the control of, and occupies positions corresponding to the governor. The small lay shaft also occupies corresponding positions, but the excentric upon it is mounted with the dead centre at the bottom, so that at light loads it gives little or no motion to the floating lever. The steam from the receiver is led to the 60 lb. pressure range through a non-return valve, and this range, in addition, receives a supply direct from the boiler through a reducing valve, so that its wants are met, whether the engine be running or not, and if the load on the engine is insufficient to provide all the steam required the deficiency is automatically made up by this valve.

The working of the arrangement is as follows :—

Taking first the case where no steam is required, at 60 lb., no steam will pass out from the receiver, and the pressure in it will therefore begin to rise, lifting the small piston valve C—on the receiver servo motor cylinder to the left of the floating lever—and admitting oil below the piston in B, which will rise, and by means of the floating lever open the receiver throttle valve A, thus giving a clear way to the low-pressure cylinder. The engine under these conditions will then operate as a compound engine in an entirely normal manner, an addition to the load merely having the effect of opening this valve still further. Should the medium pressure main, on the other hand, require a full supply, the receiver throttle valve will remain closed, and the steam will pass from the receiver as quickly as exhausted into it by the high-pressure cylinder.

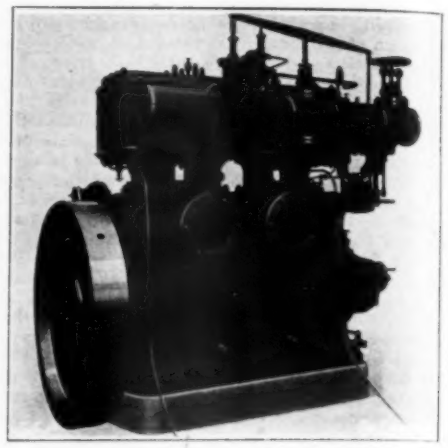


FIG. 3—REAR VIEW OF ENGINE

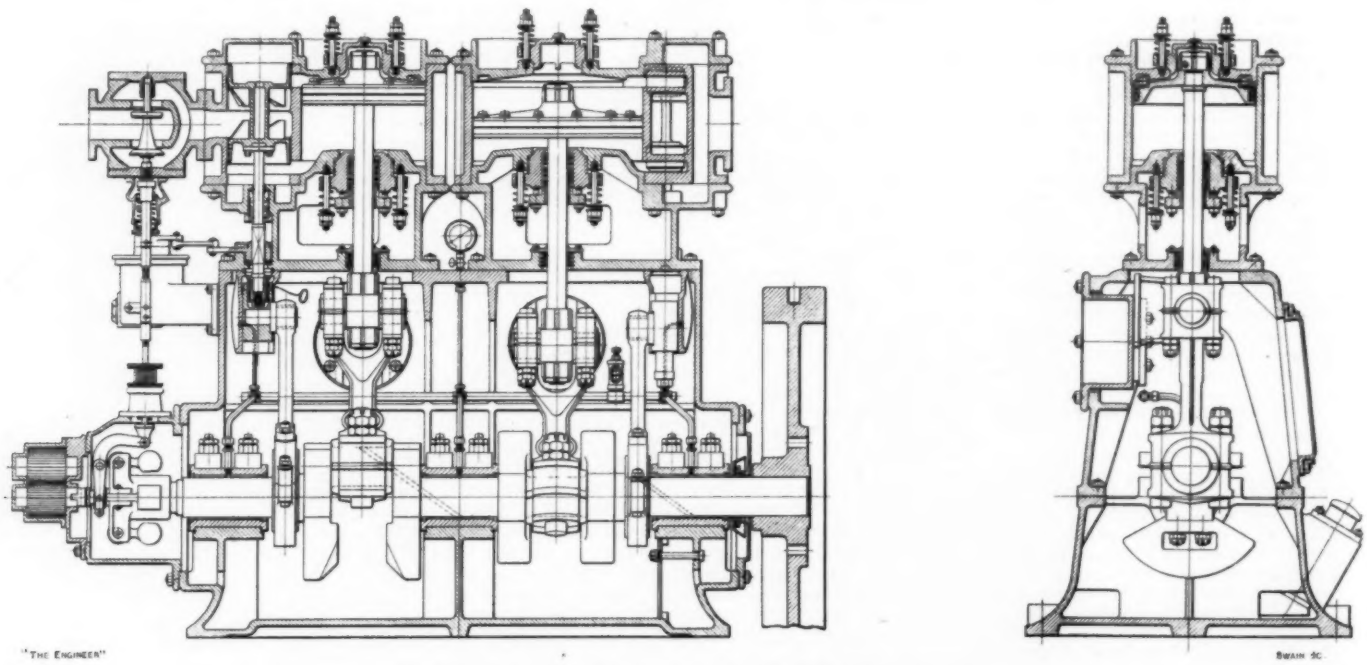


FIG. 2—SECTIONS THROUGH 200 K.W. STEAM-EXTRACTION ENGINE

The engine is designed to supply 7000 lb. of steam per hour in this way, which will give approximately 100 kilowatts in passing through the high-pressure cylinder. If the load on the engine is less than that, the automatic reducing valve supplies the deficiency, but as the load mounts up the governor causes the expansion gear servo motor cylinder to give a later cut-off in the high-pressure cylinder. On reaching 100 kilowatts the movement of the servo motor piston, and therefore the excentric coupled to the floating lever, is sufficient to open the receiver throttle valve A, admitting steam to the low-pressure cylinder, where it gives the additional power required.

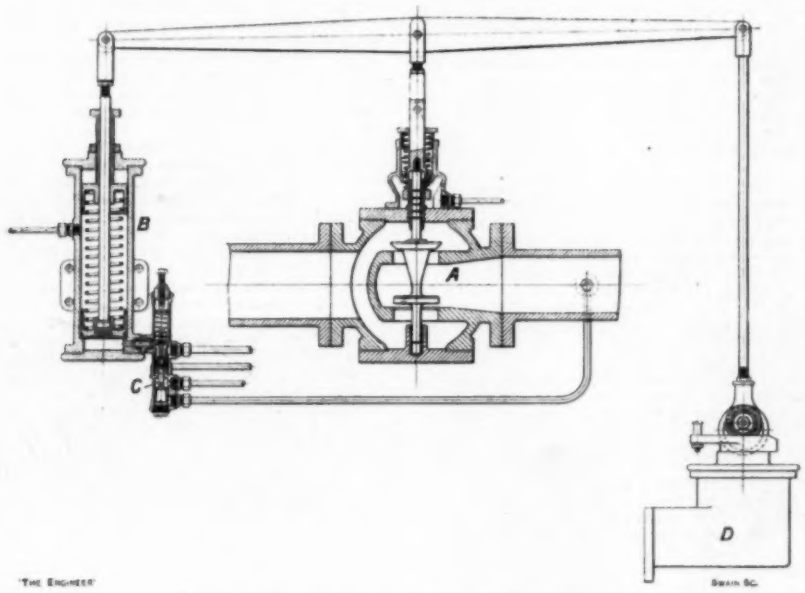


FIG. 4—ARRANGEMENT OF STEAM RECEIVER CONTROL

The whole operation is very sensitive, and is covered by a difference of about 3 lb. between the maximum and minimum receiver pressures, while it is claimed that the engine speed between no load and full load does not vary more than 2 per cent. After passing through the low-pressure cylinder the steam is exhausted at about 10 lb. for boiling and similar purposes.

It is, of course, important in a case of this kind, where the exhaust steam is used in the preparation of articles for consumption as food, that there should be no contamination by oil, and the engine is arranged to operate without any oil supply to the cylinders on the lines introduced by Messrs. Ashworth and Parker some sixteen years ago. A large number of engines of this type have been supplied by them for driving paper-making machines, bleach works, dye works, laundries, textile finishing machinery, sugar machinery, and many other purposes where clean steam is necessary. We understand that the first engine constructed on these lines is still running 128 hours per week or the equivalent of about forty years of factory driving, and that no more replacements have been necessary than for a lubricated engine.

The successful operation without lubrication is made possible by the casting of the cylinders upon chills, which is Messrs. Ashworth and Parker's standard practice. This method produces an intensely hard mirror-like surface when ground out, eminently suitable for the piston rings, which are of the restrained type of a special hard bronze cast in chills in the same way as the piston valves.

Other points in the design of the engine may be mentioned, such as the adoption of forgings for the pistons with junk rings, which permit of the rings being removed without taking out the pistons; the very large relief valves in the cylinder covers which have proved of great service in averting accidents through flushes of water in the cylinders; the double piston valves to the low-pressure cylinder having less clearance surface and volume than a single valve; the marine type of crosshead with a flat side at the back, which gives a very open roomy interior to the casing; the strong form of the connecting-rod with support for the bolts throughout their length, thus avoiding bending stresses, and bearing shells for the white metal of cast steel; the mild steel keeps to the main crank shaft bearings and other minor points. The oil circulating pump is of the gear wheel type driven direct from the crank shaft. This type was adopted by the builders about twenty years ago, after some years' experience with the valveless reciprocating type. The oil before passing to the pump goes through duplex strainers placed on the suction side. Instead of being "drowned," as is usual in the body of the engine in which position the job of removal for cleaning is disagreeable, an ingenious use of the suction has been made to enable the strainers to be placed above the oil level on the front of the engine, where they are easy of access and can be removed without soiling the hands. A quarter turn of the cap permits either to be withdrawn, shutting off its connection to the oil pump and at the same time locking the other strainer in place.

The governor and expansion gear, which are the subject of patents by Mr. F. O. L. Chorlton, are of special interest. From Fig. 5 it will be seen that the governor is attached to the end of the engine crank shaft, while connections from the governor sleeve to the throttle valve and expansion gear are substantial in design and as direct as possible. The "speeder" spring, by which a 5 per cent. alteration in speed may be made, is mounted concentrically with the coupling rod to the throttle valve, thus avoiding additional levers and joints. The governor is not of the type usually associated with high-speed engines, which has two weights with tension springs attached to pins in the weights. An experience of the ordinary type and its faults decided Messrs. Ashworth and Parker to discard it in favour of a type which could, if necessary, be made isochronous, *i.e.*, to give the whole range of travel with an infinitesimal change in the speed. Many designs are capable of arrangement to fulfil these conditions, but they are unstable, and if fitted to an engine would cause it to hunt violently. This fault is overcome in the governor under consideration in the following manner. The governor is fitted with four weights in place of the customary two so as to give great power in as small a space as possible. Each weight is carried on a bell crank arm supported on a ball bearing pivot, and finishing at the other leg with a toe of gear-tooth form bearing against the face of a circular piston E sliding inside the machined interior of the governor body. An extension of the piston forms the sleeve, from which the governor movement is transmitted to the exterior by the usual collar and levers. On the other side of the piston is the spring opposing the centrifugal force of the weights. It is in two lengths divided by a diaphragm F, which also forms a piston sliding in the governor body. A supply of oil derived from the forced lubrication system enters the governor body by way of a small hole in the centre spindle, and a passage G in the shaft leading from the nearest bearing. This supply fills the governor body, proceeding from the inner chamber to the outer by a small

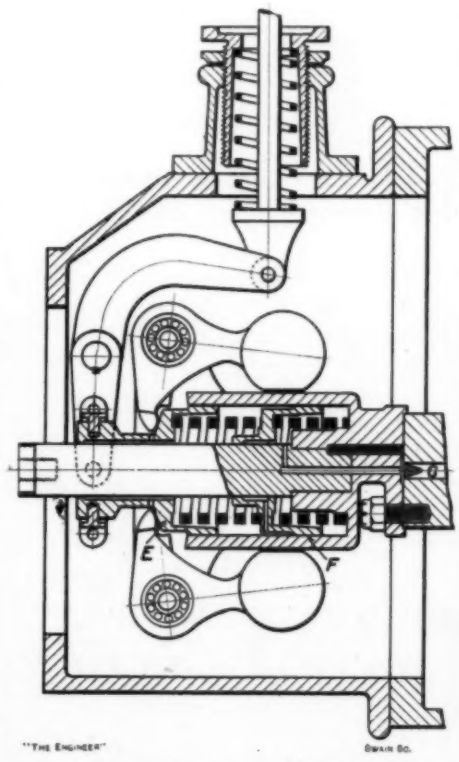


FIG. 5—ARRANGEMENT OF ENGINE GOVERNOR

passage in the diaphragm, and from the outer through holes in the sleeve to lubricate the pins and collar.

The springs together are proportioned to equal approximately the force of the weights at all positions at the required speed, and if no oil were present the governor would hunt violently; when full of oil the passage through the diaphragm is, however, small enough to retard its movement, thus altering the period of oscillation of the inner spring, which effectually damps out any attempt at hunting. At the same time, the slowing down is not so pronounced that any material reduction is made in the rapidity of action of the governor, and in actual practice a momentary variation caused by an abrupt alteration of load is checked, because the governor having isochronous springs moves earlier and with greater power than one having a considerable speed variation. A speed variation of 1 per cent. between no load and full load with an entire absence of hunting is possible, while the momentary variation on throwing off the full load may be reduced to 5 per cent.

To the coupling rod between the governor and the high-pressure throttle valve, the lever controlling the expansion gear servo motor is connected at a point about half way. This servo motor is of a somewhat novel design, enabling many connections to be dispensed with in the expansion gear. The construction can best be understood by a reference to the illustrations in Fig. 6, which show the servo motor to be of a more or less cylindrical shape divided into two portions H and J. The lower portion J presents an open side to the interior of the engine casing—to which it is bolted—and through this opening the oil under pressure from the forced lubrication system which operates the servo motor is admitted, and the oil exhausted finds its way back to the engine base. In the side of this lower portion is a short shaft having on its outer end the lever

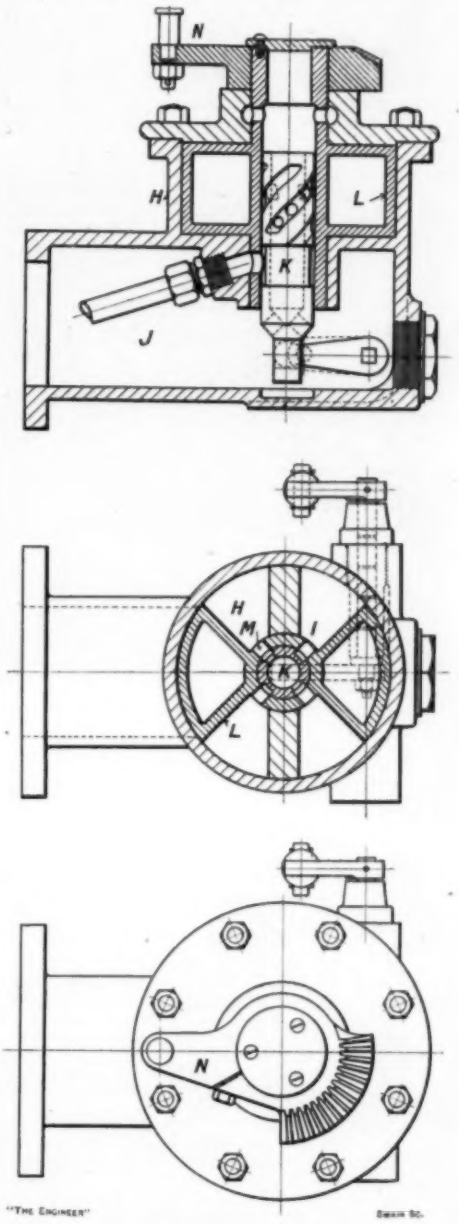


FIG. 6—THE SERVO MOTOR

coupled to the rod between the governor and throttle valve, and on its inner end a toe lever actuating a central vertical piston K, with spiral ports or grooves, which is situated in the hollow axle of the rotating piston L on the servo cylinder proper. This cylinder is formed in the upper part of the body. It is of circular shape, and is divided into two portions by plates cast with the cover. The piston L consists of a hollow axle in which the piston valve K above mentioned slides, having two opposite segmental wings which fit closely in the cylinder and work, one in each of the chambers into which the cylinder is divided by the plates in the cover. Round the hollow axle are four small ports M, open or shut according to the position of the piston valve. By means of a channel round the piston valve, oil under pressure passes up two opposite spiral grooves and enters by two of the ports M at opposite sides into the cylinder, so tending to rotate the piston. The remaining two ports allow the oil on the other side of the wings to exhaust into the remaining spiral grooves in the piston valve where, through a number of holes, it passes into the hollow centre, out at the bottom, and back to the engine base. As the piston L rotates, the ports M move out of the sphere of action of the spiral grooves, and the piston stops until the piston valve K is again moved by the action of the governor, admitting oil to one or the other side of the wings, and exhausting from the opposite sides according to the direction of the movement. From this description it will be understood that the semi-rotary piston moves only as the governor moves, and for a pre-

cisely similar proportion of its travel except that it is arranged so that something less than the total governor travel gives the full movement to the servo motor. This ensures that the control of the engine by the alteration to the cut-off in the high-pressure cylinder takes place at the heavier loads with the throttle valve wide open, and at the lighter loads by throttling at a fixed cut-off, experience having shown this arrangement to give the greatest economy over the whole range of load. The rotary motion of the servo motor piston is communicated to the high-pressure piston valve by means of a lever N mounted upon an extension through the top cover of the axle or centre stalk of L, and a link to a corresponding lever riding upon a squared portion of the high-pressure piston valve spindle. Usually in high-speed engines the high-pressure piston valve is mounted free upon the spindle, and is turned by means of rods dependent from the top of the valve chest and sliding in the valve, the rods being connected by linkage to a servo motor or directly to the governor. This arrangement involves a number of wearing parts inside the valve chest, where they are not easily accessible and imperfectly lubricated.

In the Ashworth and Parker engine the valve spindle is rigidly bolted by a flanged end to the valve, while the vertical pressure is taken care of by two strong ball thrusts in the valve spindle crosshead. These thrusts are, of course, amply lubricated—as is the squared portion of the spindle—and can be inspected with a minimum amount of trouble. The makers inform us that many years of experience have shown the arrangement to be exceedingly satisfactory.

The generator is mounted upon a combined bed-plate along with the engine and exciter with the rotor coupling bolted to the engine fly-wheel. It was supplied by Bruce Peebles and Co., Ltd., Edinburgh. For working in connection with exhaust utilisation schemes, Messrs. Ashworth and Parker have supplied over 500 engines of this class.

Oil-Driven Pumping Plant at Chipstead.

THE illustrations, Figs. 1 and 2—page 626—are views of a pumping plant at Chipstead, Surrey, belonging to the Sutton District Water Company. The plant comprises two heavy oil engines of the twin-cylinder horizontal type made by Crossley Brothers, Ltd., Manchester, each capable of an output of 170 brake horse-power as a constant normal load, and 188 brake horse-power as a maximum load for a period of one hour, when running at 190 revolutions per minute. One of the engines—Fig. 1—is direct coupled to a pinion shaft, from which a Worthington-Simpson treble-ram pump for high lifts is driven through gearing at either of two speeds, *i.e.*, to deliver 1000 gallons of water per minute against a head of 388ft., or 1333 gallons against 280ft. maximum head. The second engine—Fig. 2—drives a vertical spindle four-stage turbo pump by Sulzer Brothers, for deep pumping. In this case, the main drive is by means of six ropes to a horizontal shaft, from which the vertical spindle is actuated through gearing having a ratio of 1 to 2.4. This pump has been built for lifting 1250 gallons per minute against a head, including suction and friction, of 220ft. at a pump speed of 850 revolutions per minute, the maximum brake horse-power at the gear shaft being 134, or, alternatively, for delivering 1250 gallons against a head of 270ft. at a pump speed of 950 revolutions per minute, and requiring 150 brake horse-power at the gear shaft.

The plant has been in normal operation for considerably more than a year, and our object in referring to it is to call attention to the excellent results of a trial of the plant which was undertaken in January last by Mr. W. A. Tookey, M.I. Mech. E. In his report, Mr. Tookey states that the engines had not been specially prepared for the trial. The fuel used on the test, which lasted ten hours, was British petroleum fuel oil, having the following analysis :—

Specific gravity	.897 at 60 deg. Fah.
Calorific value	19,485 B.Th.U. gross, 18,200 net 10,825 calories gross, 10,100 net
Analysis	Carbon, 84.2%, hydrogen 12.4%

The deep well pump lifts the water from the well to a tank, about 20ft. above the ground level, and, after treatment, the water passes forward to the high lift pump, and is then delivered to either or both of two reservoirs, one of which corresponds to a head of about 270ft., and the other to a head of about 330ft.

HIGH LIFT PUMPING PLANT.

During the earlier portion of the test the mean quantity pumped was 1345 gallons per minute against a head of 271.5ft. This is equivalent to 110.7 water horse-power, and, allowing for the friction of the pump as stated by the makers, to 145 brake horse-power, or a pump efficiency of 76 per cent. The mean rate of fuel consumption at this period was 60.9 lb. per hour, and is equivalent to 0.42 lb. per brake horse-power hour and 0.55 lb. per water horse-power hour. On a heat basis, this is the equivalent of 197 foot-pounds of work done for each British thermal unit (gross) contained in the fuel consumed.

During the later portion of the test the mean quantity pumped was unchanged, but the head was increased to 328ft., corresponding to 133.7 water horse-power and 168 brake horse-power, or a pump efficiency of nearly 80 per cent. During a period of two hours, when uniform conditions prevailed, the mean rate of consumption was 70 lb. of oil fuel per hour. Thus the engine was then consuming 0.416 lb. per brake horse-power hour, equivalent to 0.526 lb. per water horse-power hour, and 207 foot-pounds of work performed for each British thermal unit (gross) in the fuel consumed.

DEEP WELL PUMPING PLANT.

The total weight of oil used by the engine driving the deep well pumping plant was 440 lb. in 605 minutes, equivalent to 43.7 lb. per hour. Under uniform conditions during 6 hours the mean volume of 1345 gallons per minute against a mean head of 150ft. represents 60.9 water horse-power. The equivalent brake horse-power is computed at 94 brake horse-power on information obtained from Messrs. Sulzer Brothers, and the pump efficiency, including gearing, was therefore 65 per cent. During the same period the steady rate of fuel oil consumption was 42.2 lb. per hour. Thus, the rate of fuel consumption was 0.45 lb. per brake horse-power and 0.693 lb. per water horse-power hour, or equivalent to 157 foot-pounds of work done per British thermal unit contained in the fuel consumed.

The table below summarises the principal figures.

It will be observed from the difference between water horse-power and brake horse-power in the table that the deep well pump was less efficient—65 per cent.—than the high lift pump—80 per cent.—under the prevailing conditions. These efficiencies would at the designed outputs have been increased to 68 and 82 per cent. respectively if the deep well pump had been under load conditions requiring 150 brake horse-power as designed, instead of only 95 brake horse-power, the fuel consumption of the deep well pumping unit would naturally have been considerably improved. Indicator diagrams were taken at regular intervals throughout the test from both engines, and from the regularity of them it is computed that the rate of fuel consumption reached the excellent figure of 0.335 lb. per indicated horse-power hour.

The engines were under Mr. Tookey's close personal observation for eleven hours, and he states that at no time did any mechanical or other detail give the slightest anxiety, and the ease in which starting was effected with both engines from cold was very striking. Consequent upon an unusual series of silencing chambers fitted to prevent any possibility of complaints from the owners of residential property, Mr. Tookey states that the back pressure on the exhaust of both engines must have a detrimental effect and cloak the true efficiency of both engines. For this reason, the satisfactory figures obtained for fuel consumption indicate higher thermal efficiencies than had been anticipated, and therefore they were subjected to close scrutiny before being certified in his report.

Sutton Water Company's Pumping Plant.—Table of Results.

Duration, hours.	Volume of water, gallons per min.	Head, feet.	Horse-power, per cent. of normal rated.				Fuel consumption, pounds per hour.			Foot-pounds of work per B.Th.U. (gross).
			Water.	Brake.	R.p.m.	B.H.P.	Total.	Per W.H.P.	Per B.H.P.	
Deep well set—										
6	1345	150.0	69.0	95	85.0	55.8	42.2	.69	.445	157
High lift set—										
5	1345	271.5	110.7	145	100.0	85.2	60.9	.55	.420	197
2	1345	328.0	133.7	168	100.0	99.0	70.0	.53	.416	207

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

HAIR CRACKS IN GLAZED BRICKS AND GLAZED TILES.

SIR,—If it were not for reasons which will be set out below, the writer would be content to accept the explanation which will occur first of all to any of us, viz., that the hair lines or cracks appearing in the glazed surface of tiles and bricks are solely due to temperature changes as are the crazed maze of criss-cross lines in old plates and saucers. The writer does not exclude entirely the thermal change explanation as partly contributory in some cases, but he submits that it does not go far enough. If it were the sole explanation, it would be logical to expect that such cracks would invariably start in the positions of greatest temperature change, *e.g.*, over or at the side of fire-places or near radiators. That is not the case. There is also need for a hypothesis which will account for the remarkable continuity of these lines which can be traced from brick to brick and tile to tile in spite of the intervening cement between the tiles or bricks, very much in the same way that we can trace roads or contour lines on an ordnance map which has been cut into sections and pasted on linen. Admittedly, not every line is continuous ; in some cases, the glazing is thicker on some bricks than others. Where the glazing is thicker the lines are fewer than on adjacent bricks or tiles with thinner glazing. But if on any brick or tile the general direction of these hair cracks is horizontal or vertical or diagonal, the continuing lines which can be seen on adjacent bricks or tiles will be horizontal or vertical or diagonal in direction at the line of juncture. A series of horizontal lines in one brick may start as horizontal lines in the next ; there they may bend round to a vertical direction, and further on in another brick may be found to bend round further, and appear finally as horizontal lines above or at or below the starting point. Moreover, definite nodal points free or relatively free from hair cracks can frequently be found. It is for these reasons that the writer is unable to accept the usual explanation of alternate thermal expansion and contraction as the reason for these lines. An extended examination will show that these lines are analogous to the Chladni sand figures—produced when a tuning fork in a condition of vibration touches a glass plate on which fine particles of sand are scattered—illustrations of which are to be found in most books dealing with elementary physics. It appears reasonable to conjecture that the rhythmical regularity of these lines is really due to the elasticity of all substances subjected to alterations of compression, and that the very small tremors of an exceedingly minute character, say 10^{-8}in. produced by street traffic will, so long as the frequency is constant, produce regularly spaced strains and inequalities in the surface of the material under the glazing. These, in their turn, produce strains in the glazing, which in time occasion the cracks in the glazing.

June 2nd. W. P. DIGBY.

TELEPHONES.

SIR,—In your number of February 13th (which has just reached me) Mr. A. H. Hall makes the interesting suggestion that the small number of telephones per thousand of population in Great Britain, as compared with some other countries, may be due to racial characteristics. He thinks that the "auditive perception" may not be so well developed, and the liking for intercourse by audible conversation therefore not so strong as in countries where telephones are popular.

Is it not perhaps an even more probable explanation that the telephone is comparatively unpopular in Britain because it is instinctively felt to violate that most precious and unique of British characteristics, the acknowledgment of the right to privacy ?

When analysed, the convenience of the telephone is seen to rest upon an irrational principle ; its harmonious use requires that *both* parties should happen to be at leisure at the same moment, which is a most improbable contingency ; and failing this, it seems impossible to deny that one of the two must be distracted from whatever he was doing when "rung up," and thereby more or less annoyed. Although it is doubtless too late now, what would have been better than telephones is some form of printing telegraph universally distributed whereby the subscriber could type out his message in the machine of any other subscriber without attention, and the latter could reply at his leisure in the same way. This would also possess the advantage which the telegraph always has over the telephone—as anyone who has had experience in using both under similar circumstances, such as in the Army or on railway work, must acknowledge—of encouraging a concise, definite style of expression instead of a verbose, inconclusive, muddle-headed one. J. E. H.

Kelantan, Malaya, April 30th.

THE LATE FRANCIS H. TREVITHICK.

SIR,—It may interest your readers to learn that Francis H. Trevithick was appointed to the position of superintendent of the locomotive engine department of the Grand Junction Railway Company in February, 1841, and that from the opening of the works in the year 1843 until 1857 he was the one and only chief mechanical engineer at Crewe and was responsible for the design and construction of the locomotives as well as the discipline of the department.

The first entirely new locomotive engine constructed at Crewe was completed on February 20th, 1845, and was No. 49, Columbine, a 6ft. passenger engine. This engine has been preserved at Crewe and is now to be seen at Wembley, and it bears a plate affixed to it, stating that F. H. Trevithick was then chief mechanical engineer. The position held by Alexander Allan was that of foreman of locomotives at Crewe, and when he resigned in September, 1853, his salary was £500 per annum.

His successor was the foreman from the Preston shed, who was succeeded by the foreman from the Carlisle shed. These particulars are taken from official records and are therefore authentic and correct. WALTER LAIDLAW.

Manchester, May 30th.

NEW DUTCH TORPEDO-BOAT DESTROYERS.

THE recent announcement that two further torpedo-boat destroyers are to be built to Yarrow and Company's designs in Holland, implies a remarkable tribute to the success of British designs for fast naval vessels. It will be remembered that last summer the Netherlands Government invited competitive designs for torpedo-boat destroyers from well-known builders of such vessels in Great Britain, America, France and Germany. The Yarrow design was selected as being the best among those submitted, and the Scotstoun firm was entrusted not only with the supervision of the vessels during their construction ; but was also asked to supply from Glasgow certain boiler parts and forced draught turbine fans of the Yarrow pattern, as well as certain machinery parts. Altogether four destroyers have been ordered by the Netherlands Government, three of which are being built at the yard of Burgerhout's Shipbuilding and Engineering Company, Ltd., Rotterdam, and one at the Royal De Schelde Yard at Flushing. The main characteristics of the new destroyers are given in the following summary :—Length overall, 322ft. ; beam, 31ft. ; depth, 18ft. 9in. When fully loaded the displacement will be about 1620 tons. The machinery is of the Parsons geared turbine type, with special cruising turbines for speeds up to 15 knots. The designed speed in the normal condition is to be 36 knots and that in the loaded condition 34 knots. Steam will be generated in three boilers of the latest Yarrow pattern, fitted with the firm's patented superheaters and air heaters. The armament for the new vessels includes four 12 centimetre fifty calibre guns, two 7.5 anti-aircraft guns, and three triple 53 centimetre torpedo tubes. A complete system of firing control is fitted, while provision is made for the installation of bomb throwers and mine launching gear.

COMPETITION among the railway companies has led to an innovation by the London, Midland and Scottish Railway which will be a boon to the holiday maker. On alternate Wednesdays excursion trains are being run from Manchester to the Lake District and to North Wales. The trains are provided with restaurant cars, and the fares include payment for breakfast on the outward journey and dinner on the return. From an operating point of view the experiment is a costly one, as additional weight has to be carried and the train has to be wholly of corridor stock. On the whole, though, it will be a source of profit, as the hotels, refreshment rooms and restaurant cars are the only paying accessories of the railways just now. Last year the London, Midland and Scottish, with nearly five millions invested in hotels, made a profit therefrom of £681,263, or nearly 14 per cent.

A Mechanical Shovel for Subway Work.

ALTHOUGH the mechanical shovel, whether operated by steam, compressed air, or electricity, has found wide and successful application for open digging work, it has, we believe, but rarely been employed in tunnels and subway excavations. The problems presented in designing such a machine are several. First of all, the overhead clearance must be as small as possible, and it should remain constant throughout the course of the various digging motions. Again, the power of the shovel, both as regards the bail-pull and the thrust of the dipper, must not be in any way impaired as compared with the ordinary design of shovel, but must be rather augmented, because digging conditions are likely to be more severe when working in confined spaces than when operating in an open cut. Another important consideration is the height of the dipper and dipper arms, which, when swinging to the discharge position, should not exceed the clearance limit as regards height, and yet must remain free to move quite clear of the objects around the shovel so as to give free dumping height into the trucks which are to be loaded.

A new type of shovel designed to meet the general conditions above outlined has recently been designed by the Bucyrus Company, of South Milwaukee, Wis., U.S.A., and has been set to work on subway construction in Philadelphia. The accompanying illustrations serve to show the machine performing both its digging and loading operations. As regards general design the new three-quarter yard shovel differs little from the firm's standard steam shovel of the same capacity. Like the steam shovel, it is mounted on caterpillar tracks, while the sub-frame, swinging frame and general machinery arrangements are quite similar. In the machine we are describing compressed air is employed as the working medium, although the shovel is, we are informed, equally adapted for electrical operation. The boiler, it will be noted, is replaced by a neatly housed air receiver. The reciprocating engines for the various shovel motions are retained, but they are modified by employing special pistons and cylinder gland packings so as to use compressed air at 110 lb. pressure.

The chief dimensions of the machine are such that it can work with a clearance height of only 13ft. The dipper is designed to dump its load at a maximum radius of 18ft 6in. from the centre line of the shovel, and the maximum clearance beneath the open dipper is 8ft. above ground level. In designing the machine it was arranged that its digging capacity would be equally maintained when digging right from its base up to the full limit of 13ft. in height. With regard to swinging clearance, that at the back end of the shovel is on a radius of 9ft. 6in. from the centre pivot, whilst the boom point swings at a radius of 15ft. 2in.

The illustrations we reproduce are taken in a subway which is now under construction in Philadelphia, where, we learn, eight of these shovels are giving satisfactory work. One shows the digging operations in progress, while the other, which illustrates the machine dumping, serves to show how the dipper arms go right up to the top point of the boom, thus maintaining a level clearance height over the whole shovel. The amount of air which is used by each shovel during normal working is, so the makers inform us, about 400 cubic feet per minute at a pressure of 110 lb. per square inch. In tunnel and subway work the chief difficulty experienced is that of serving the shovel with trucks or lorries. On the contract we have referred to, loading rates as high as 505 cubic yards per day of eight hours have actually been recorded with the shovels in question. The contractors have also reported that the time lost on account of repairs and stoppages has so far been less than 1½ per cent. of the whole time of working. It is only six months since this new type of shovel was introduced, and the new design would appear to have given satisfactory results in practice. We are indebted to the London branch of the Bucyrus Company, whose office is at Iddesleigh House, Caxton-street, Westminster, S.W. 1, for particulars and illustrations of this new type of excavating machine.

MECHANICAL SHOVEL FOR USE IN SUBWAY WORK

THE tramway system of Walsall made a profit of £23,000 last year, as compared with £14,000 during the preceding twelve months.

South African Engineering Notes.

Natal Electric Railway.

OWING to heavy floods in Natal during March, the working of the portion of the main line which is being electrified had to be done entirely by steam for some time, the power-house having suffered. With the resumption of operations at the power station, a service of electric trains recommenced between Ladysmith and Estcourt on April 20th. The temporary schedule under electric working provided for a daily service of eight goods trains of 1430 tons each and one passenger train.

Union Mineral Statistics.

The mineral output of the Union of South Africa for the month of March, as furnished by the Department of Mines and Industries, are as follows :—Gold, 823,817 oz., value £3,499,351 ; silver, 100,174 oz., value £14,192 ; osmiridium, 374 oz., value £10,236 ; diamonds, 208,350 carats, value £678,522 ; coal, 1,109,642 tons, value £333,786 ; copper ore and concentrates, 296 tons, value £13,102 ; tin ore and concentrates, 97 tons, value £14,953 ; other minerals, value £20,744.

The coal output—sales—is the largest for over twelve months, but its value at the pits mouth is £8000 less than that of the output for October last, when 1,100,022 tons were produced.

The output of osmiridium is notable in view of the prevailing activity in platinum ores in the Transvaal. The whole is obtained from the Rand Gold Mines. So far only a few have attempted the recovery of the metal—those that have substituted the corduroy cloths in place of the amalgamation plates—but the production is rapidly increasing, as the figures for the last four years show. In 1921, 509 oz., worth £6801, were recovered ; in 1922, 761 oz., £13,165 ; 1923, 1784 oz., £43,528 ; 1924, 4298 oz., £108,168.

Natal's Coal Resources.

The Department of Mines and Industries of the Union of South Africa recently published a report on the coalfields of the Province of Natal, prepared by Mr. W. J. Wybergh, of the Gelogical Survey. The carefully drawn statements and conclusions are, unquestionably, the result of a great amount of labour on records, as well as inspections of collieries and outcrops, and the report should be of great service to persons desiring information concerning the coals of Natal. It is accompanied by a number of plates showing, on a fairly large scale, the various Natal coalfields.

According to Mr. Wybergh the coal reserves of Natal amount to 8,808,437,000 tons. The amount of "proved" coal is, however, very small compared with the "estimated" and "undetermined." Taking as an illustration the coal contained in the Utrecht District, which Mr. Wybergh estimates at 6,106,892,000 tons, we find that 94,098,000 tons only is "proved," 1,132,794,000 tons "estimated," while 4,880,000,000 tons are "undetermined." "Proved" coal is taken to mean coal which has been sufficiently prospected to warrant immediate opening up where the quality and economic conditions permit. "Estimated" coal is coal the existence of which is fairly certain but which requires further investigation to warrant the expenditure of capital. "Undetermined" coal is that about which little is known in detail, but of the probable existence and extent of which there is good general geological evidence sufficient to warrant prospecting. There has been included in the total of the coal reserves the coal contained in seams between 2ft. and 3ft. thick but not less. There are, it is pointed out, wide differences in the natures of these coals as regards calorific value, volatile contents, &c., and a large quantity is probably of low calorific value ; indeed, the percentage of such coal is put as high as 55 per cent. for the "proved" coal reserves of the Utrecht district.

Electricity for Durban.

After years of negotiation an agreement has been come to between the Electricity Supply Commission and the Durban (Natal) Municipality. The Commission binds itself to equip and erect a station in the Durban area—at Congella—which is to contain an initial installation of two 12,000-kilowatt steam turbo-generating sets, and is to be ready on or before October 31st, 1927. The Municipality, while still operating its present Alice-street Station, will purchase from the Commission's station 48,000,000 units per annum at .29d. per unit—based on a cost of coal at 16s. 6d. per short ton, and subject to adjustment *pro rata*—plus a standing charge of £33,500 per annum ; also subject to adjustment according as the number of units and the "agreed maximum demand" of 9000 kilowatts are exceeded or reduced. The present borough engineer of Durban will be appointed manager of the new undertaking without his existing appointment being modified in any way.

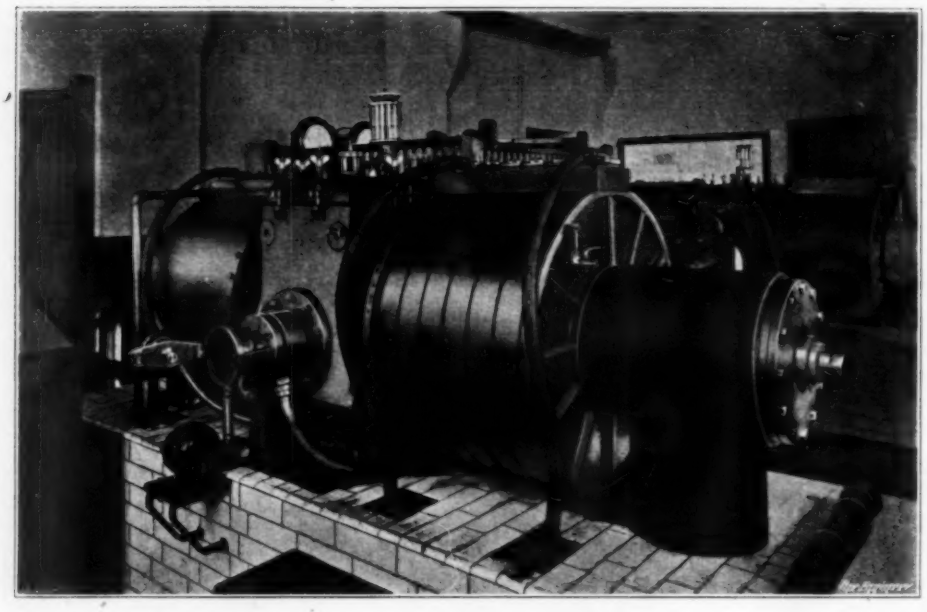
What is Quicksand?

IN a recently published article, entitled "What is Quicksand ?" our contemporary, the *Canadian Engineer*, draws attention to the interesting view, expressed a short time back by Colonel Charles R. Gow, speaking before the Sanitary Section of the Boston Society of Civil Engineers, that quicksand should be considered less as a material than as a condition. It is pointed out that the readiness with which it flows and becomes unstable is not a natural quality of the material, but develops as an inescapable consequence of an unbalanced head that causes water to flow upward through the sand. Whether the particles be fine or comparatively large, the characteristic quicksand condition is created. The presence of a certain amount of clay, forming as it were a lubricant to the wetted sand grains, aids in bringing about the undesirable condition in question.

According to Colonel Gow, states our contemporary, "a very common condition in excavation is the occurrence of a substantial depth of fine sand underlaid by a stratum of quartz sand or gravel charged with ground water under a head sufficient to induce an upward pressure in the layer of the find sand above it. If a trench or pit be excavated in the fine sand below the level of the ground water, and the inflowing ground water is pumped or drained from the excavation, the unbalanced head will create an upward flow of water through the fine sand into the bottom of the trench, the friction of the rising water lifting the sand grains and causing a condition of unstability. If the depth of excavation below ground water level is considerable, the flow becomes sufficiently rapid to bring in quantities of sand which are naturally replaced by other material flowing in laterally from the surrounding soil with the effect of creating a disturbance of the ground on either side of the excavation for a considerable distance. Sometimes this trouble is obviated by driving a series of well points through the bed of fine sand into the coarse water bearing stratum and keeping the ground water level at this point below that of the excavation. Even if there be no substratum of coarse sand and the fine sand be merely saturated with the ordinary accumulation of surface water, completely filling its voids, a sheeted excavation into this material may create a lateral flow of the sand as soon as water is removed from the trench. In consequence, it becomes necessary to drive the sheeting to a considerable depth so as to increase the distance which the water must travel under the cutting edge of the sheeting to enter the trench. It is invariably a troublesome and difficult operation to carry out excavation in such material, but with the well-established precautions of the construction industry, it is being done regularly without greater inconvenience than perhaps a high excavation cost per cubic yard and the loss of a considerable amount of time.

"In spite of the distrust of foundations on sand expressed by laymen, it is an established fact that where lateral flow of the material is prevented, sand makes an excellent foundation material. The yielding property becomes pronounced only when a flow of water is set up, and if such flow can be prevented, the sand particles, however fine, may produce a very substantial bearing resistance. In many cases footings have been placed on wet sand and have carried loads of two tons or more per square foot for years with practically no settlement. If, on the other hand, there is any likelihood whatever of flow being set up, either through adjacent excavations or through drains or for any other reason, the engineer should make sure that his foundations are deep enough not to be affected by the transport of material."

THE ARC ROOM AT LEAFIELD



The Leafield Coupled Arc.

WHILE there are many who believe that the valve will soon displace the arc and high-frequency alternator for the generation of continuous waves for wireless communication there are others who have doubts about the matter. In his book on the Poulsen arc generator, published in 1923, Mr. C. F. Elwell says that it has been calculated that over 20,000 K.W. of arc transmitters are in use, and that although many with something else to sell predict the death knell of the arc, it is very probable that it will be many years before the last arc generator will have been definitely abandoned in favour of another less costly system. It is the one good system, he continues, that is not covered by a mass of patents which are employed, as a rule, to dictate the terms and conditions under which it may be used. Practically all other wireless systems capable of being employed in high-power stations are, he says, in the hands of the wireless combination of English, American, French, and German companies. Even though something quite superior should be developed, it is quite likely that the arc generator, which can yield very useful results and be obtained at a reasonable price, will still hold a large part of the field.

It is well known that the Post Office employs arc transmitters in some of its wireless stations, and it is equally well understood that they have caused a good deal of disturbance to other wireless users. If directly coupled to the antenna the Poulsen arc produces disturbance of two kinds —the emission of harmonics and "mush." The former are definitely tuneable and can be heterodyned to a musical note, and the latter manifests itself as a hissing sound. The cause of harmonics is the slight departure from sinusoidal form of the current in the oscillating circuit; but a properly designed arc and aerial circuit may reduce the strength of the harmonics below what is normally obtained from a valve oscillator of similar power working on a plain aerial, although in practice the harmonics and especially the "mush" are still strong enough to give trouble. The cause of "mush" is a little more obscure, but it is probably associated with the irregular frequency of the fundamental wave. The arc is an ionic contrivance, and on a plain aerial connection has a frequency which in consequence of the ionic action inside the arc chamber cannot be expected to be very constant. If a sine wave has its frequency changed at a sinusoidal rate, or, in other words, undergoes frequency modulation, an infinite series of harmonics of the sum and difference of the fundamental frequencies is obtained, and when any one harmonic of this series happens to fit in with the harmonic resonant point of the antenna system it gives rise to radiation at that frequency. With the arc the fundamental frequency is undergoing frequent discontinuous changes, and it is to be expected that the harmonics due to these irregular changes will form a continuous spectrum of disturbance which is ready to emerge at any harmonic resonant point of the antenna.

Recently two of the Post Office engineers, Major A. G. Lee and A. J. Gill, described in a paper read before the Wireless Section of the Institution of Electrical Engineers the experiments and improvements made at the Leafield wireless station with a view to eliminating the harmonic and "mush" disturbances. From the theory outlined above it was to be expected that the provision of a primary oscillating circuit with concentrated capacity and inductance would tend to prevent the harmonic E.M.Fs. giving rise to currents of sufficient magnitude to cause disturbance. The antenna system, with its distributed capacity and inductance, necessarily has harmonic resonance positions, so that the introduction of the primary circuit should cut down the harmonics before they get into the antenna system. The provision of the coupled circuit involved radical changes in the lay-out of the plant, and as the station was almost in continuous use, the task of making the alterations was necessarily a lengthy one. A diagram of the circuit as designed by the Post Office engineers is given in Fig. 1, the values of the inductance and capacity being those used on a transmitting wave of 12,350 m., but the circuit can be operated at wave lengths of from 8500 m. to 1500 m. In selecting the electrical dimensions of the parts of the circuit it was recognised that practical limitations would prevent the circuit being designed to give the maximum theoretical efficiency.

The inductive type of coupling has been used in all the authors' experiments at Stonehaven, Northolt and Leafield, because it is relatively cheaper than a condenser coupling, and it can be so made that it is continuously variable. The Northolt circuit has an auto-transformer coupling, while the Stonehaven and Leafield circuits are transformer coupled in the ordinary way. It is well known that an arc on plain aerial excitation is liable to unsteady frequency variations, and one of the pleasing features of the coupled circuit working at Leafield is the remarkable steadiness of the frequency and the purity of the note.

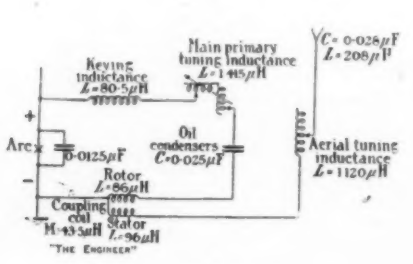


FIG. 1

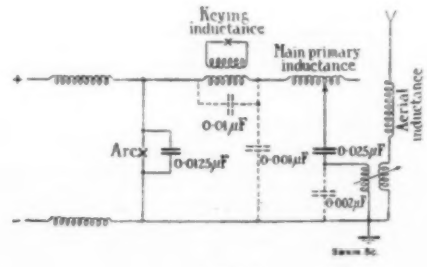


FIG. 2

The lower frequency harmonics which had formerly troubled Devizes and other wireless stations were found to have been eliminated by the coupled circuit, but no improvement was observable on the broadcasting band of wave lengths which were still interfered with by some of the higher harmonics of Leafield. Attention was therefore paid to tracing the source of these harmonics at the station itself and suppressing them by various expedients. At Leafield the primary circuit condenser has a capacity to earth of .002 μ F, which, as will be seen from the dotted lines in the right of diagram Fig. 2, acts as a shunt across the coupling coil for these higher harmonics. Owing, however, to the somewhat congested lay-out of the circuit at Leafield there is fairly close proximity between portions of the primary and secondary circuits, with a possibility of stray coupling between these points. On account of their proximity to the aerial coil the keying coils probably transferred the harmonics directly to the aerial coil without passing through the shunted coupling. The steps taken to reduce this effect were to shunt the keying coils by placing a condenser of .01 μ F across them and by connecting this condenser to earth through a condenser of .001 μ F, the object of which is to keep the harmonic potential of the keying coils as low as possible. A small resistance was also placed in the key side of the coils for damping purposes. The condenser shunted across the arc was also found to be a source of harmonics, as was proved by the great reduction of the series of harmonics when the condenser was removed. This condenser, however, performs too important a function in stabilising the frequency and in increasing the current output to allow it to be removed. Various experiments in the nature of adding damping to this circuit were made and were found to reduce the harmonics considerably, but the remedies applied were not permanently adopted on account of the increase of the "mush." At Northolt the extinction period being very short, the shunt condenser has only a small effect in stabilising the frequency and the damped shunt condenser circuit is in use. Damped circuits across the direct-current choke coils were also tried, but produced no improvement.

It was then thought that direct radiation from the primary circuit was the cause of the disturbance in the immediate vicinity of the station. Steps were therefore taken to screen the building, and they were found to cause a considerable improvement locally. By this time the only place from which complaints were received relating to disturbance on the broadcasting band was a town about 6 miles from Leafield, although places not so far away were immune. The telephone circuit from this town to the station was suspected, and tests indicated that it was at the root of the trouble. Steps were therefore taken to place air core choke coils of 2000 μ H inductance and 8 $\mu\mu$ F self-capacity in the telephone and telegraph wires, and this has quite removed the trouble. It is rather curious how these harmonics could get on the telephone wires, because the circuits are in an underground cable for about a mile from the station. Apparently the cable sheath carried harmonics. The choke coils were placed in the wires where they emerged from the cable and also at a point where they entered the adjacent town.

The keying of the coupled arc is carried out by keying the primary circuit only, as indicated in Fig. 2. The difference in frequency between spacing and marking is only 80 cycles per second, so that the amplitude of the secondary current is nearly the same in both cases. This constancy of amplitude avoids the considerable disturbance in the neighbourhood of the fundamental frequency which is present on systems employing a suppressed wave during spacing.

The half-tone illustration shows the Leafield arc room. The cathode holder in the foreground is shown open and the carbon to be seen on the right has been withdrawn from the holder. The right-hand field coil casing has been removed for cleaning purposes

INSTITUTION OF ELECTRICAL ENGINEERS: WESTERN CENTRE.

THE Western Centre of the Institution of Electrical Engineers held its summer meeting at Dursley, in Gloucestershire, on Friday, May 22nd. The members of the party to the number of about 100 journeyed to the town from Bristol and South Wales in motor cars and were taken to the works of R. A. Lister and Co., Ltd., where they were entertained to luncheon by the firm.

After luncheon the fourteenth annual general meeting was held, under the chairmanship of Mr. W. Nairn, the Chief Electrical Engineer of the Bristol Tramways and Carriage Company. The chief business was the declaration of the ballot to fill four vacancies on the Committee. The following officers and Committee were elected:—Mr. J. W. Burr, M.I.E.E., borough electrical engineer, Swansea, chairman; Mr. W. G. Heath, A.M.I.E.E., electrical contractor, Plymouth, first vice-chairman; Mr. C. G. Morley New, M.I.E.E., city electrical engineer, Cardiff, second vice-chairman; Mr. F. H. Corson, M.I.E.E., city electrical engineer, Gloucester; Major E. I. David, M.I.E.E., chief electrical engineer, Powell Duffryn Steam Coal Company, Aberaman; Sir A. Whitten Brown, K.B.E., M.I.E.E., Swansea; Mr. W. E. Hardy, M.I.E.E., general manager and engineer, Bath Electric Tramways, Ltd. In response to an appeal by Mr. T. Hood, Bristol, a collection was made for the I.E.E. Benevolent Fund, which realised the sum of £12.

The party was afterwards divided into small groups and escorted on a tour of inspection of Messrs. Lister's extensive works. The inspection over, the party was entertained to tea by the firm, and the Chairman, in proposing a hearty vote of thanks to R. A. Lister and Co., Ltd., on behalf of those present, said that the visit had been most interesting and instructive and had been thoroughly enjoyed by all. He also said that everybody was agreeably surprised that such a large proportion of their output was shipped to America and the Colonies. The vote of thanks was seconded by Mr. Arthur Ellis, of Cardiff. Sir Ashton Lister, Kt., responding, referred to the chairman's remark about the shipments abroad, and said that this went to prove that England was not dead yet.

BRITISH WATERWORKS ASSOCIATION.

BY permission of the Corporation of the City of London, the fourteenth annual general meeting of the British Waterworks Association will be held in the Council Chamber of the Guildhall, London, an Wednesday afternoon, July 1st next, the following three days being devoted to visits. The following order of proceedings has been arranged:—On the Wednesday morning at 11 a.m., there will be a meeting of the Executive Committee of the Association in the Council Chamber. At 12.45 p.m., luncheon will be partaken of at the Cannon-street Hotel by the members of that Committee, by invitation of Mr. Alderman Musgrave. At 2.15 p.m., in the Council Chamber, members will be welcomed by the Right Hon. the Lord Mayor. After the transaction of business, the President for the coming year will be elected and deliver his address, which will be followed by the reading and discussion of a paper, entitled "Conservation of Sources of Water Supply," by Mr. Joseph Parry, M. Inst. C.E., late Engineer-in-Chief to the Liverpool Corporation Waterworks. Sir Alexander

Houston has promised to prepare a paper, entitled "The Purification of London's Water Supply," dealing chiefly with the method of chlorination and the taste of chlorinated water. In the evening at 7 p.m. there will be a reception at the Hotel Russell by Mr. Alderman C. G. Musgrave, chairman of the Metropolitan Water Board, after which at 7.30 p.m. the annual dinner will take place.

On the Thursday at 10 a.m. motor coaches will leave the Metropolitan Water Board head offices, Rosebery-avenue, for a visit to the Staines reservoirs, the Littleton reservoir, intake and works, and the Walton works. In the evening at 9 p.m. there will be a reception at the Goldsmiths' Hall, Foster-lane, E.C. 2, by invitation of the Prime Warden and Wardens of the Worshipful Company of Goldsmiths.

On the Friday a visit will be paid to the works of the East Surrey Water Company at Purley and Reigate and the West Wickham pumping station of the Metropolitan Water Board. Motor coaches will leave the Metropolitan Water Board head offices, Rosebery-avenue, at 10 a.m. On returning at 6 p.m. the party will inspect the County Hall.

Saturday, July 4th, will be available for visits to other works of the Metropolitan Water Board, according to the desires of members for either a whole day or for half a day. The three suggested alternatives are :—(*a*) Whole day : Four works, viz., Barn Elms works, Hampton pumping station and filtration works and Surbiton and Ditton works (return about 5 p.m.). (*b*) Half a day : Green-lanes (Stoke Newington) Works or the liquid chlorine plant at Highfield ; and King George Reservoir and the Humphrey pumps, Chingford (return 1 p.m.). (*c*) Half a day : Barn Elms works, high-pressure primary and slow sand filters (return 1.15 p.m.).

The Trade of the Port of Wellington, N.Z.

FROM the annual report of the Wellington Harbour Board for the year ending September 30th, 1924, which has just reached us, we learn that there was a marked increase in the trade of the port during that period, as compared with that of the preceding year. The net registered tonnage of 2977 vessels arriving was 2,996,337 tons compared with 2680 vessels of a net registered tonnage of 2,816,104 tons, an increase of 180,233 tons, or 6.4 per cent. The average tonnage of the vessels arriving was 1006 tons, which was slightly less than for the year before. The total tonnage of goods landed at, or shipped from the port for the year amounted to 1,560,206 tons, as compared with 1,315,592 tons, an increase of 244,614 tons, or 18.5 per cent. This total includes all cargo handled at the port, in place of the tonnage passing over the town wharves only, as was the case in previous years.

The total imports of general cargo received during the year amounted to 1,251,788 tons, as compared with 1,056,838 tons for the year before. There was an increase of 89,397 tons from British and foreign ports, 94,082 tons from Australian ports, and 19,127 tons from castal ports ; a total increase of 202,606 tons. Transhipments showed increases in the British, foreign and Australian trades amounting to 30,446 tons, but the coastal transhipments decreased by 38,102 tons, the net transhipments being 7656 tons less than in the year before. The British, foreign and Australian transhipments all showed a satisfactory increase. The decrease in coastal transhipments is due to vessels trading direct to some of the smaller ports.

The imports of timber continued to show a large increase, there being 21,607,609 super feet imported, compared with 12,833,262ft. the year before, or nearly 9,000,000ft. more. The tonnage of coal received was 468,268 tons, which was a little more than in the year before. Of the amount, 80,745 tons were for Government use and were exempt from wharfage. The amount is 29,296 tons more than was imported by the Government for use the previous year, an increase of 56.9 per cent. The total cargo of all classes exported was 308,418 tons, an increase of 49,664 tons, or 19.1 per cent. Exports of meat, tallow, butter and cheese amounted to 96,892 tons, or 3162 tons more than for 1923. Cheese showed an increase of 10,033 tons, while butter was 2171 tons less, and meat 4700 tons less. The total wool and skins shipped amounted to 173,815 bales, as compared with 170,071 last year. The transhipments increased by 5938 bales, but the shipments from shore and rail were 2194 bales less. Hemp, including tow, shipped outwards amounted to 54,211 bales, an increase of 5991 bales, about one-half of which were transhipments. The revenue from storage, while still low as compared with 1922 and previous years, showed an increase of £5151 3s., of which £1644 16s. 1d. was derived from the Board's cool store.

The financial results for the year were very satisfactory. The total income for the year was £433,070 13s., as compared with £365,273 12s. 9d. for 1922–23, and the expenditure was £385,647 11s., as against £353,275 14s. 5d., leaving a net surplus on the year's working of £47,423 2s., compared with £11,997 18s. 4d. The working expenditure showed an increase of £16,882 18s. 5d.; repairs and maintenance were greater by £3061 17s. 4d. ; payments for interest amounted to £49,500, compared with £47,064 8s. 7d., or £2435 11s. 5d. greater than in the year before. The increase in net revenue was due, it is explained, to the increase in shipping, the larger amount of cargo handled at the port, and to economies in working.

THE chairman of the London and North-Eastern Railway, Mr. William Whitelaw, spoke recently in the General Assembly of the Church of Scotland on the subject of Sunday travel. He said it was the business of the Church to see that no public demand arose for the running of trains on Sunday. He wanted to say, definitely and clearly, that if, in spite of Church effort, public demand did arise, then no railway company could ultimately resist it. Unless the demand was very real and very certain, no such service would be instituted, but they could not resist it if it did arise.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Whitsun Holidays.

BUSINESS has been very restricted this week, most of the heavy engineering firms and other consumers of iron and steel having had three or more days holiday for Whitsuntide. Order books in the majority of cases were so scanty that manufacturers were not at all inconvenienced by the stoppage, but their hopes that in the interim additional business would be forthcoming have only in a few instances been realised. Producers of raw material who attended the weekly meeting of the Midland iron trade in Birmingham to-day—Thursday—were disappointed with the volume of demand. Even though smelters were content to accept reduced prices, transactions were for small tonnages for immediate needs of consumers. Forward buying has practically ceased. There was a fair call for structural steel, but other branches were as quiet as before the holidays. The outlook is considered far from promising, especially as continental competition appears to be increasing in intensity. The best that can be said of the iron and steel industry in this district is that the tone is rather hopeful, and that a little more business has been placed. More orders are passing through the hands of merchants, but unfortunately a large proportion of them is for foreign material.

Staffordshire Iron.

The Staffordshire iron trade reports a little improvement, orders for wrought iron having come forward with somewhat more freedom. There appears to be a little reaction in favour of wrought iron for gasholders, wagon building, &c., owing to its more durable qualities. The Black Country, however, is suffering from the shipbuilding slackness, the demand for chains and anchors being much below the normal. There are a few branches of industry in which a regular turnover is being made, but, taking the South Staffordshire trade all round, manufacturers who have been hoping against hope are asking themselves whether lower prices are not the only condition upon which expansion is possible. The marked bar houses are very well supported, and makers of other special grades of bar iron are receiving regular orders. But the general run of trade in Crown and common bars is very discouraging. The disparity which exists between the prices stereotyped in Staffordshire and those of competing districts aggravates the instability of the position. Medium grade finished iron—Crown quality—is obtainable as £12 10s., which is 5s. below the usual quotation, while British makers who cater for the nut and bolt trade complain that nearly the whole of the business, in this class of iron, is going abroad. This is no new condition, and, with the present wide difference between British and Belgian quotations, it would be rather surprising if it were otherwise. Some of the Black Country nut and bolt makers are better occupied than recently. The tube mills are only moderately engaged, and the demand for British strip has fallen off somewhat.

Galvanised Sheets.

Makers of galvanised corrugated sheets are booking orders steadily at £16 10s. for 24-gauge, with an occasional concession for a good order. Mills are well employed, and are likely to be for some months to come.

Cheaper Pig Iron.

Pig iron values in this district have fallen further, being now something like a crown per ton less than a fortnight ago. Both Northamptonshire and Derbyshire smelters used every endeavour to maintain the old rates, but with coke cheap and plentiful, and consumers continually pressing for reductions, they were compelled to give way. Buyers claim to be able to secure Derbyshire No. 3 foundry pig at £3 12s. 6d., and Northamptonshire at £3 7s. 6d. It is certain, however, that all sellers are not to be persuaded to submit to these rates, though all have to recognise the change brought about by the eagerness of individual producers to ease their responsibilities in view of the unpromising outlook. With coke plentiful and weak in price, there is an impression that pig iron prices may go still lower. As a rule, orders are accompanied by appeals for quick delivery, a sign that stocks in makers' hands are small. Exporters of pig iron are for the most part unsuccessful in meeting the low prices now accepted on the Continent. Some little improvement in engineering has increased the call for pig iron, but it is still a good deal below the normal. Very little forge material is called for in the depressed state of the Staffordshire trade.

Steel.

There is little alteration in the steel position on the week. Prices are irregular, demand is small, and competition, both internal and external, is keen. There is no enlargement of the consumption of structural steel in the district, and openings outside are hard to find. Orders when they are forthcoming lack bulk. In this branch continental competition is acute. British-made angles and joists are quoted at £8 10s., and small steel bars are generally obtainable at about £8 15s. Birmingham merchants report a decidedly larger turnover, but foreign prices are sufficiently attractive to encourage the purchase of Belgian material for shipment from Antwerp, and a good deal of Indian business has been handled in this way, finished bars, for example, being obtainable at £5 f.o.b. Antwerp, a figure much below the British quotation. Rather large quantities of steel tube strip from Germany have been bought here at £8 5s., against the local price of £9 10s. for steel and £12 10s. for iron. One of the signs of enterprise is the issue by some steel works of daily rolling lists, indicating the exact sizes to be rolled next day, offering their customers quick delivery. This is an innovation, mill owners having in the past contented themselves with issuing such advices weekly. Steel plates are in general £9 5s., but as low as £9 has been accepted. German agents are reported to have been very busy during the past fortnight seeking orders for plates, bright strip and heavy forgings. It appears that the home demand there is far below the large capacity available, and an attack upon the British market is now a policy generally agreed upon. Mild steel billets continue to be offered at prices ranging from £6 15s. to £7 per ton. Belgian billets are obtainable at about £6. Steel wire rods have been cheapened lately, and although costing more than foreign, are frequently preferred on account of quality.

Birmingham to the Sea.

The case for improving the water communication between the Midlands and the Mersey has been placed before the Minister of Transport by an influential deputation of Midland authorities and representatives of industry, who not only emphasised its importance to inland towns, but urged its value from a national standpoint. The need for increased transport facilities is being recognised more and more by industrialists in this district. It is claimed that this route is the shortest possible to serve the areas concerned, that it can be constructed quickly, and that no insuperable difficulties, either in regard to engineering or the supply of water, are likely to be encountered. The estimated cost, £6,600,000, is an indication of the magnitude of the project. I gather that Birmingham at present inclines to view this scheme—the linking of the Midlands with the Mersey—as the most promising of several under discussion. It certainly seems to have enlisted more support—and the promise of support on more practical lines—than any of its rivals. Wolverhampton, the Black Country, the Potteries, and Liverpool all seem to regard this canal extension as a thing that will profit them as much as it profits Birmingham, and as an undertaking claiming financial as well as sentimental backing. Certainly such backing will be necessary if the required capital is to be found. Furher developments will be followed with considerable keenness by manufacturers in this area, and a conference of all interests concerned might possibly lead to a scheme sufficiently attractive to secure some Treasury assistance.

Lower Pay for Midland Miners.

A substantial reduction in the proceeds of the mining industry in the Eastern area is shown in the returns of the Wages Board. They permit of an addition of only 50.62 per cent. to the standard wages for June, compared with 57.04 per cent. for May. Workers in the highest grades will thus receive about 6d. per shift less. Cannock Chase stallmen will receive a minimum of 9s. 11d. a shift, as against 10s. 4d. in May and 11s. 8d. in June last year, and 10s. 2d. in June, 1923. This decrease in wages, coupled with the fact that the pits are working short time, is a heavy blow for the miners. The pits in the district were closed on Monday, Tuesday and Wednesday for the Whitsun holidays.

Midland Ironworkers' Wages.

It is intimated that the wages regulated by the sliding scale under the Midland Iron and Steel Wages Board will remain unaltered from June 8th to August 1st next. The previous ascertainment showed a reduction of 2¼ per cent., bringing puddlers' wages to 65 per cent. above the basis rate of 13s. 6d., at which figure they will remain for the next two months.

LANCASHIRE.

(*From our own Correspondents.*)

MANCHESTER.

General Outlook.

THE condition of the markets in Manchester this week is, of course, extremely quiet. Practically, Tuesday is the only day on which business is transacted, although some firms are open for a few hours on Wednesday. There is, however, not the slightest inclination to do any business, and it is difficult to get any reliable quotations. The general feeling, however, is that prices all round are easier, and that when business opens again next week we shall see evidences of this. There can, of course, not be very much alteration in prices until the time comes when an advance is possible. There is plenty of room for a rise, but no room at all for a fall ; at any rate, so long as present rates of wages and present hours of labour obtain. Nevertheless, it is undoubtedly difficult to keep prices from sagging so long as there are more sellers than buyers anxious to do business.

Metals.

The markets for the non-ferrous metals are extremely quiet here, and with the exception of tin there seems to be little expectation of any movement. Of course, tin is incalculable, but the general belief here seems to be in favour of higher prices. Certainly the feeling is very much stronger now than it was in April, and there seems to be less fear of a collapse. With regard to the statistical position, it is anticipated now that shipments from the East will be considerably larger than was first expected, so that visible supplies at the end of the month may not be so much reduced as some people thought. This, of course, should check any panic if there should be a tendency that way. There is some expectation of an increased buying movement from America. In the copper market things have been very quiet lately. For over a week the local prices for refined copper here did not move, and it is not often that one sees such prolonged stagnation. There is no disposition here to speculate or to buy more than is required for fairly prompt use ; but confidence in the present prices is no doubt returning. Naturally, there is no business being done here this week, so that there is no means of testing prices, but they are practically unchanged. Of course, what is wanted in the copper industry is such a feeling of confidence in the future as would lead all consumers to carry much larger stocks. This would at once

relieve the industry of a great burden, and would stimulate prices all round. It is generally admitted that there is not much probability of any fall in copper prices; but from this conviction to a belief that an advance is imminent is a step which has not been taken. The position in lead and spelter does not alter to any extent. Lead is in rather plentiful supply, but that has not caused any fall in the market yet. Of course, the price is comparatively moderate; but actually it remains high.

Pig Iron.

The market here for foundry iron was very quiet on Tuesday and Wednesday, and after that there was no further business in Manchester. Some of the Lancashire towns work during the latter part of the week; but in Manchester no business will be done until next week. The outlook for pig iron prices is far from good, and consumers here seem to be fairly confident that they will buy No. 3 at 80s. delivered here when the market opens again. As a matter of fact, some makers of Derbyshire foundry iron have already offered pig iron at 73s. 6d. per ton on trucks, which is equal to 81s. in Manchester; and Northamptonshire iron has been offered at 67s. 6d. on trucks, or equal to 80s. 2d. per ton here. The only question of interest now is whether, even if ironfounders can have the iron at 80s., they will begin to buy in substantial quantity. So far as experience goes, the consumer of iron, or for that matter of any commodity, never will buy largely for future needs until the market begins to go up; and so far as one can see there is no prospect of a rising market in pig iron before the autumn, and probably not then. Hence sellers are no doubt in for a slow and bad time in the pig iron trade. The Cleveland market was dull, and No. 3 was slightly cheaper, but not sufficiently so to make any difference in the feeling here. Hematite was easy again, and can be had here at about 92s. 6d. delivered. As for Scotch, there was no business, but the minimum price here is still 101s. 6d. per ton delivered.

Finished Material.

There is only a very small business being done here in manufactured steel, and the tendency is to cut the prices. Probably good straight orders for joists and angles might be placed at £8 5s. per ton, for the works are anxious for such orders to keep them going, but for small orders of irregular sizes £8 10s. is wanted. For steel plates the ostensible price here is £9 5s. per ton. Flat bars could probably be done at £9 delivered. Round bars vary a good deal, but a first-class make of shafting bar is quoted at £10 5s. to £10 10s. The position in the finished iron market is quite unchanged, and the reduction of the price of Lancashire Crown bars from £12 10s. to £12 has made no difference.

Scrap.

Dealers in old material seem more depressed than ever. For steel scrap there is no market at present, and there seems to be a distinct fear that when Sheffield begins to buy again the price offered will not be more than 60s., if as much. Some Lancashire dealers are refusing now to buy heavy melting scrap at more than 50s., and they talk of coming down to 45s. The latter price is as much as it is worth for the South Wales market. For heavy wrought scrap some of the Lancashire forges will still pay 75s. per ton delivered. For cast scrap there is no regular market now, and the ideas of prices vary from 75s. to 80s. per ton.

BARROW-IN-FURNESS.

Reduced Output.

There has been a reduction in the output of hematite pig iron in this district, as was forecast in previous notes. The demand had become so small that makers had been accumulating stocks, and now the two furnaces at Barrow and also the two furnaces at Millom have been damped down. There are only nine furnaces in blast in the North-West District, and there may be a further reduction at any time. There are sufficient stocks at the various works to satisfy all demands for a month or two, and with the steel departments idle there is little consumption in that direction. The trade has not been so poor for a considerable time, and at the time of writing there does not seem to be a single sign of revival. Scotland, the Midlands and Wales are taking very little iron indeed, and the demand for special qualities is very small. There is some iron ordered for delivery in America, but it will come out of the Barrow stocks, which are not small.

Iron Ore.

The iron ore trade received a blow by the damping down of furnaces, and there will be an immediate restriction of output at the mines, some of which are working "day to day." The amount going out of the district is negligible. Foreign ore imports, both from Spain and Norway, will be reduced. The shipments of ore from Kerkenes, in Norway, to Barrow are now getting bigger than those from Spain.

Steel.

The steel trade is very quiet indeed. The Barrow rail and merchant mills are idle; in fact, the only departments working at Barrow are the hoop and small section departments, which are fairly well situated for orders. The state of trade in Cumberland is about the same, and both the rail and sleeper mills are idle this week.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Departments.

THIS has been a short working week, owing to the Whitsuntide holidays, the duration of which has varied at the different works, according to the state of the order books. On the raw material and semi-manufactured steel sides things show no improvement. The demand for pig iron, steel billets, scrap and bar iron is very poor, and inquiries are on an equally small scale. A good deal of activity is maintained at the Parkgate works, but at Stocksbridge, in the Rotherham district, and in Lincolnshire, a large amount of the melting plant is standing idle. On the manufactured side, the position is better, but is by no means satisfactory. The plants, as far as they are in operation, are working with fair regularity, and some valuable contracts are being executed. Only partial occupation is found for the axle and tire plants. Private owners of wagons have not given out any considerable contracts this year. The overseas demand for rolling stock and material has been poor for some time, and shows no improvement. The rolling mills are receiving numerous orders, but most of these are on a small scale, and output is declared to be below the remunerative level.

Hopes of Improvement.

Optimism as to the future is still to be found. In some quarters hopes of an early improvement are entertained. Shipbuilding already shows some turn for the better, and an improvement in that direction would be of great value to Sheffield, as the industry is, of course, a great feeder of the city's heavy trades. Nothing in the nature of a general revival is, however, expected in Sheffield before the closing months of the year. The departments producing steel sheets, wire and cold-rolled strip are all quieter than they were a month ago. Several local firms which specialise in colliery tools, castings and appliances are feeling the depression in the coal industry rather acutely. Makers of agricultural tools and edge tools are well employed, and the export prospects in these trades are fairly good. The automobile industry continues to make large demands on Sheffield for stampings and special steel, and there is a growing demand for stainless steel for engineering purposes.

A Sheffield Grain Store.

There has just been completed at the Sheffield Wharf of the Sheffield and South Yorkshire Navigation Company an interesting addition to the city's labour-saving equipment in the form of a silo, consisting of thirty-four bins, with a storage capacity for nearly 2500 tons of grain. A group of the city's millers has co-operated in the erection of the silo, and the plant has been supplied by Henry Simon, Ltd., of Manchester. About 30,000 tons of wheat is brought to the wharf, in canal barges, every year, and hitherto it has come in sacks, into which it was placed at the port of arrival. Now, however, it will come in bulk, and will be unloaded by means of a bucket elevator that delivers the grain into a weigher, inside the silo building which automatically registers the weight and tips it into another elevator, whence it is taken to the bins. During its passage the grain is subjected to a strong draught of air which gives it a preliminary cleaning and keeps the machinery free from dust. Each barge carries from 80 to 100 tons, and the unloading can now be carried out under the supervision of one man in about four hours, whereas the discharging of the same quantity in sacks would keep six men occupied six hours. When the grain is required for the mill, it is drawn from the bins into bulk wagons holding about 5 tons each.

Cutlery and Plate.

The falling off in the demand for cheap stainless table knives has assumed serious proportions, with the result that the small firms, which do the bulk of this trade, are experiencing considerable difficulty. As frequently reported, the amount of business done by the better-class houses has been on an unsatisfactory scale for a considerable time. On both sides therefore the present situation is the reverse of happy. Shopkeepers' purchases have reached a very low ebb, and some firms have recalled their travellers in order to reduce the losses which fruitless journeys were entailing. There is some falling off in the export trade in cutlery, but it still keeps up to a very fair level, and it does not appear that German cutlery is making any substantial inroads into the colonial markets. As far as the plate and silver branches are concerned, their turnover has been declining all through the year, and the position now compares very unfavourably with that of twelve months ago. It is said that many manufacturers of cutlery and plate alike are carrying on at a loss.

Hull and Grimsby Schemes.

The Hull City Council has adopted the great scheme for the abolition of level crossings, of which I gave details last week. Another important Humber project is announced from Grimsby, where the Town Council has decided, subject to the approval of the Ministry of Transport, and to the receipt of a grant from the Unemployment Grants Committee, to construct a new bridge, of the lifting type, over the Alexandra Dock at Corporation-road. The estimated cost of the scheme is £51,000. The bridge will be wide enough to allow of the laying of a double tram track, with 9ft. of carriageway in addition, and two footpaths, each of a width of 7ft.

New Sea Wall at Hornsea.

An important project, serving at once for the protection of the coast and the pleasure of holiday makers, has just been carried out at Hornsea, on the Yorkshire coast, and was formally inaugurated this week. It consists of an extension of the sea wall, both north and south, bringing up the total length to about half a mile. The extension on the north runs for a distance of 450ft., and is constructed of mass concrete, supported on steel piling. On the south side, a new solid concrete wall has been constructed for 825ft. The wall at its northern point is bent seaward, forming a bastion. Other improvements have also been carried out. The total cost of the work has been £45,000, of which 65 per cent. has been provided by the Unemployment Grants Department. The scheme was prepared by Mr. A. R. Roberts, the engineer to the Hornsea Council, and has been carried out by Mr. J. T. Levitt, contractor, of Hull and Bridlington.

Restarting a Colliery.

The depression in the coal industry continues to be felt in this district, and there have been more cases of suspension of operations, though not on a great scale. An item of news in the opposite and more satisfactory direction comes from the Hartington Colliery of the Staveley Coal and Iron Company, where the company is hopeful of reopening the Silkstone seam. The colliery was closed many years ago, but for some time past the company has been engaged in exploring the workings, with a view to deciding upon the practicability of reopening. Coal has already been reached, and, providing further tests justify anticipations, and a satisfactory price list can be arranged, it is likely that work may be resumed within the next month.

A New Mines' Safety Station.

A new experimental station for the carrying on of research work to improve the safety of mines has been established by the Government Mines Department at a place called The Frith, on the moors near Buxton. The station will be opened shortly, and demonstrations of scientific methods for diminishing accidents in mines will be given periodically to those engaged in the management of mines.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron and Steel Exports.

THE struggle with adversity in the iron and steel export trade continues. Although prices have been cut to almost rock bottom, producers in the North of England are finding it extremely difficult to secure overseas business. This fact is reflected in the export returns for the Cleveland district during May, which show a decline of nearly 6000 tons, as compared with the shipments in April, and are 25,000 tons less than the total shipped in March. The shipments of pig iron during May amounted to 29,219 tons, as against 30,635 tons in April, the decline being chiefly due to smaller continental exports. Of the total, 13,510 tons were shipped to foreign destinations and 15,709 tons coastwise. Italy was the principal foreign customer, with 5050 tons, while Germany received 1680 tons, Belgium 1503 tons, and America 1260 tons. The exports of manufactured iron and steel totalled 43,075 tons, as compared with 43,975 tons in April. As usual, India and Ceylon figure conspicuously with a total of 9460 tons, as against 5895 tons in April, and among other large buyers were the Argentine Republic, 6294 tons; Kenya, 3117 tons; Australia, 1966 tons; and the Netherlands, 1639 tons.

Cleveland Iron Trade.

In no direction is there yet discernible the slightest sign of improvement in the Cleveland pig iron trade. The quietness which has ruled on the market for some time past has been accentuated this week, owing to the holidays, and business has been more or less in abeyance. On the whole, the industry is in a serious plight, and the difficulty of obtaining even a modest share of foreign business has been increased by the further fall of the franc and the lira. Prices all round are weak, and makers are quite prepared to bargain for business. Their quotation of 75s. per ton is merely for small quantities of No. 3 G.M.B. Cleveland pig iron, and this price can be shaded for substantial orders. No. 1 foundry is quoted 80s., No. 4 foundry 74s., and No. 4 forge 73s. per ton.

Hematite Pig Iron.

There is little change in the position of the East Coast hematite pig iron trade. The production is still more than equal to requirements, and stocks are being accumulated at some of the makers' yards. The general market quotation for mixed numbers is unchanged at 80s. 6d. per ton, and 81s. for No. 1, but here, again, better bargains may be struck by purchasers with a good order.

Ironmaking Materials.

The foreign ore trade is in a lifeless state. Consumers show no interest whatever in the market, and fight shy of fixing up new contracts in view of the uncertain outlook in the iron trade. Best Rubio ore is nominal at 22s. per ton c.i.f. Tees. The demand for blast-furnace coke has fallen off considerably, and with supplies abundant good medium furnace kinds are being pressed on the market at 22s. per ton delivered at the works.

Manufactured Iron and Steel.

The manufactured iron and steel trade still displays a tendency to sag. The position is not actually devoid of hope, but the volume of trade coming forward is very limited. Orders are for very small quantities, and this fact adds to the difficulties of makers in arranging their rolling programmes. Iron and steel rivets have fallen respectively to £13 10s. and £13 per ton, but other manufactured iron and steel prices are virtually unchanged.

The Coal Trade.

The remarkable success of Northern merchants in securing the major portion of the Swedish State Railways' contract has been the chief topic of conversation in coal trade circles this week. Of the 167,000 tons allocated, 138,000 tons have been placed with Newcastle merchants, the remaining 29,000 tons having gone to Germany. Competition was very keen, and the German offers were, it is stated, beaten by the narrow margin of 1d. per ton. The fact that such a large share of the order has come to this district seems to indicate that the bottom in prices has at length been reached, and that values may become more stabilised. The contracts further appear to show that there is trade for British coals if the price is low enough, and admittedly the prices just accepted are very low, ranging from 19s. 9d. to 22s. 11d. per ton c.i.f., according to quality. Last year the Swedish State Railways contracted for 227,000 tons, and Durham and Northumberland were allocated 135,000 tons at 26s. 1d. to 31s 4d. per ton c.i.f. Apart from the placing of this important

order, there is little change in the position of the Northern coal market. Business has largely been in abeyance, owing to the holidays, and prices remain at recent levels. In the Northumberland steam coal section the demand continues limited. Best Blyth grades are inclined to be steady for early positions, owing to the drop in production caused by the holidays, and 16s. 9d. to 17s. per ton is maintained. The forward trade, however, is easy, and the quotation is nominal at 16s. 6d. Steam smalls are rather neglected, as there is no renewal of demand. Bests are in moderate supply despite curtailments in production of large steams and 10s. 6d. to 10s. 9d. per ton is quoted. The tone is easier in Durham steams on account of the general slowness of business. Durham gas coal producers are supplied with few bookings and business continues to hold off. Supplies are plentiful and indicate an easy basis at 18s. 9d. to 19s. per ton for bests, and 16s. to 16s. 9d. per ton for seconds. The coke market records no alleviation of the dull conditions prevailing, and the demand keeps slow and of small dimensions. With abundant supplies, prices are weakly held.

Ironworkers' Wages Advanced.

The report of the accountants to the North of England Manufactured Iron Trade certifies that the average net selling price of manufactured iron for the two months ending April last was £12 13s. 9.80d. per ton, as compared with £12 12s. 1.43d. per ton for the preceding two months. In accordance with the sliding scale arrangement, there will be an advance of 2½ per cent. in puddling and other forge and mill wages, commencing from June 1st.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding: Decreased Output.

STATISTICS of launches from Clyde yards during the period from January to the end of April of this year constituted a record and furnished a misleading idea as to the state of the industry. Within the period alluded to an average number of ordinary sized vessels reached the launching stage, while in each month a large vessel also was put into the water, thereby swelling the output credited to each individual month. As these vessels were launched, however, berths became vacant in which there was nothing fresh to lay down, and the rate of output was bound to slump. Consequently, when the figures for the month of May are added to the total of the preceding months, the figures show a drop of 34,500 tons, compared with the best for the five months' period. During the month of May sixteen vessels of 22,000 tons aggregate were launched on the Clyde, showing a drop of twenty vessels and 22,000 tons compared with the same month last year. Of the steamers launched three were over 5000 tons each, as follows:—Prometheus, twin-screw motor ship, 6300 tons, for Alfred Holt and Co., Liverpool; Nairnbank, twin-screw motor ship, 5200 tons, for the Bank Line, Glasgow; River Ottawa, single-screw corrugated ship, 5200 tons, for Petersen and Co., Ltd., London. New contracts are scarce, the chief item reported during May being an order on behalf of the Blue Star Line, London, for two refrigerated meat carriers of 12,000 tons deadweight, each to be built by Lithgows, Ltd., Port-Glasgow. It was also announced that Yarrow and Co., of Scotstoun, had been entrusted by the Dutch Government with the design and supervision of two additional destroyers—making four in all—to be built in Holland, and that they would supply the boilers and certain parts of the machinery for all the vessels.

Labour Affairs: A Colliery Experiment.

An experiment is being tried at the Parkhead pit, belonging to the Glasgow Iron and Steel Company. A section of this pit has been idle for over six weeks, and now a scheme has been agreed upon by owners and workers whereby the earnings of the workers are being pooled, each receiving a like sum for his labour. The men are working in squads instead of individually. The scheme has been devised with a view to reducing oncost charges, cheapening the cost of production, abolishing the system of contracting, and equalising the wages of the worker. The scheme is to be given a fortnight's trial.

Steel and Iron.

The outlook in the steel and iron trades is unchanged, and markets are dull and lifeless. The scarcity of specifications is still pronounced notwithstanding the various price concessions, buyers confining themselves to absolute requirements. Keen competition is reported for any small lots in prospect, but with general opinion favouring further decreases in prices business is difficult to conclude. Steel plates and sections and bar iron all stand greatly in need of orders, activities at the works being far below normal. Steel sheets sell with fair regularity, but stern competition reduces the prices obtained. Galvanised sheets, on the other hand, maintain a very firm front, with prices tending upwards. Pig iron continues in a state of semi-stagnation. Shipments from Glasgow harbour during the past week were only about 370 tons total bulk. Prices are nominally unchanged, but in most cases can be shaded considerably when a good order is in prospect.

Coal.

The Scotch coal industry in general continues in a most unsatisfactory position, and the outlook is discouraging. Outputs have been reduced with fair regularity for some months past, but demands have decreased almost as rapidly, and considerable stocks of all classes of fuel are held in all areas. Prices are all tending to become lower, and with fuels pressed for sale, considerable concessions can be gained by a shipper with a good prompt order. For the most part, however, buying is confined to immediate requirements. Aggregate shipments for the past week amounted to 198,734 tons, against 230,592 tons in the preceding week, and 287,053 tons in the same week last year. The home market is almost as dull as the export. Industrial wants are not improving, while household and general utility requirements are at a minimum level at present.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Steam Coal Trade.

HOLIDAY conditions have prevailed during the past week, with the consequence that there has been no development of note in the coal trade. The official holidays in the coalfield were the first three days of this week, and the Exchange did not open until Wednesday morning, so that it was not to be expected that much would be done this week. The production of coal will be substantially less for the time being, but that is not a matter of importance, in view of the fact that the demand is so negligible. The market closed last week in very disappointing style; in fact, there was scarcely any activity in any direction and the tendency of prices, though largely nominal, was towards easiness. It was quite thought at one time that there would have been considerable loading pressure right up to the holidays, but the contrary was the case. On Saturday morning it was reported that there were over forty idle loading appliances at the various docks. That is quite an abnormal number, even allowing for the exodus of vessels, the owners of which had made special effort to get them loaded and sailed in order to avoid their being detained over the holidays. Bad weather had undoubtedly held up the arrival of a number of steamers towards the end of last week, but it is questionable whether the number of arrivals during the vacation will have so replenished the docks that the collieries will be in a good position from the point of view of being supplied with empty wagons. As a matter of fact, a rather quiet time is looked forward to, as orders on the market are very restricted, and the amount of tonnage offering for employment is getting appreciably less. The position of shipowners is that they are being compelled in increasing numbers to lay up their tonnage on account of the unremunerative character of rates, both outward and homeward. This is more especially the case with tonnage of medium size employed in the Mediterranean trade, for which rates have an advancing tendency, thus making it more difficult for exports to compete for business.

Coalfield Items.

Notices which were served on the miners at Coed Ely, Tonyrefail, on account of the trade depression, expired on Saturday last, and it was expected that about 1800 men would be thrown on the unemployed list, but fortunately the management has taken steps to mitigate the effects of such action, as it has been decided to continue the working of the colliery on a single shift instead of a double shift. This means that 900 men out of the 1800 will be given work. It has, however, been decided definitely to close down the Tylchen level permanently. In the case of the Werntawr Colliery, Llanharan, the notices which were served on the workmen also expired on Saturday, so that 400 men are rendered idle. The Blaenavon collieries have now been idle for nearly two months, and the workmen are displaying a greater desire to come to terms with the management for a resumption of work. Up till recently they had rejected two offers upon which the Blaenavon Company was prepared to re-open the mines, but on Monday the Committee was authorised to make further representations to the owners with a view to negotiations being resumed. As the workmen are showing more desire to come to reasonable terms, there is a prospect that before the end of the week satisfactory arrangements will be come to.

Tin-plate Works Restart.

There is good news respecting work for tin-platers in the Swansea district, as after being idle for nine weeks the Cwmbwrla Works, belonging to Messrs. Richard Thomas and Co., recommenced operations this week, with the result that about 550 men, for a start, have been found employment.

Wages of Tin-plate Workers.

One of the matters which will in all probability come up for discussion at the meeting of the Joint Industrial Council of the tin-plate industry on Friday of this week is the position of the tinmen and their claim for increased wages. These men are inclined to take strong action, as they feel that the employers are not considering their claims as they should do. There was a meeting of representatives of the tin-plate workmen in the area extending from Briton Ferry to Llanelly and in the Swansea Valley on Saturday last at Swansea. It was quite an unofficial meeting, inasmuch as it was not convened by the union as a whole. There were about 400 delegates present, and their view was unanimous that the position of tinmen was now far worse than it was in pre-war times, owing to the fact that their base rates had not been raised. The meeting unanimously passed a resolution protesting against the indifference of the employers in dealing with their claim for an advance of 15 per cent., and requesting all the branches represented to endorse their action by handing notices in on July 1st unless their demand in full is conceded.

Craftsmen and Colliery Working Hours.

The Executive Council of the South Wales and Monmouthshire Colliery Enginemen, Boilermen and Craftsmen's Association decided at its meeting at the end of last week to press for an increase of 2s. per day on the standard rates of wages and to resist any attempt to reduce wages, as also to do all possible to prevent the breaking of local agreements. The meeting was noteworthy because of a statement by the general secretary, Mr. D. B. Jones, concerning the substitution of an eight-hour day for one of seven hours at the collieries. He said that he had reason to believe that the Government would be compelled to repeal the Seven Hours Act, and unless the mine owners and the men's leaders ceased from attempting to out-manœuvre each other in the present difficult situation, he was afraid there would be no alternative but that the employers should tender notices to the workmen. The time had come when all parties should face the situation boldly and truthfully, and co-operate in bringing about a solution of their present difficulties, instead of drifting helplessly on the rocks. This statement brought forth no dissent from the other members of the Committee, so that it is concluded that the Association is more or less committed to the policy of favouring a return to the eight-hour day.

Current Business.

The market has been practically at a standstill during the past week on account of the holidays. Prices are nominal round about those prevailing last week, though the tone is quiet, and it is feared that on account of the shortage of ready tonnage the market will develop a certain amount of irregularity for prompt loading. Very little fresh inquiry has come along over the vacation.

CATALOGUES.

RANSOMES AND RAPIERS, Ltd., Waterside Works, Ipswich.—The "R. and R." Annual for 1925.

MARSHALL, SONS AND CO., Ltd., Gainsborough.—Publication No. 1503, illustrating and describing the "Marshall" steam road roller.

THE LONDON ELECTRIC WIRE COMPANY AND SMITHS, Ltd., Playhouse-yard, Golden-lane, E.C. 1.—Stock list of "Lewcos" electric cables and cords.

FULLER'S UNITED ELECTRIC WORKS, Ltd., Woodland Works, Chadwell Heath, Essex.—List 91c, containing prices and details of dry and inert cells and batteries.

HADFIELDS, Ltd., East Hecla Works, Tinsley, Sheffield.—Leaflet 209, illustrating the improved pulling jack and leaflet 211 on "Hadfield's Rustless Steel and Iron."

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby.—Price list No. 5352 of direct-current motor control pillars, mining pattern, and descriptive list 8115 of direct-current circuit breakers for tramcar service.

THE PREMIER ELECTRIC WELDING COMPANY, Ltd., Abbey Wood, London, S.E. 2.—Price list and particulars of electrodes for electric arc welding; also illustrated pamphlets dealing with electric arc welding plants, (*a*) single-operator type; and (*b*) multiple-operator type.

THE PARSONS MOTOR COMPANY, Ltd., Town Quay Works, Southampton.—Publication No. 73, referring to auxiliary yacht installations; publication No. 74, referring to motor yachts and cruisers; and publication No. 75, on passenger and service launches, commercial and fishing craft, &c.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are informed that Mr. A. H. Besche—for many years and until recently sales director of Kerr, Stuart and Co., Ltd., of London and Stoke-on-Trent—has been appointed general sales manager of the engineering department of J. and F. Howard, Ltd., of Bedford.

MANY of our readers learned with regret that quite recently, pending the adjustment of financial matters, a receiver and manager was appointed on behalf of the debenture holders of the Blyth Shipbuilding and Dry Docks Company, Ltd. It is gratifying to learn, however, that the business of this old-established undertaking at Blyth is being carried on as usual by its officials, and that it has at the present time a fair amount of repair work in hand.

CONTRACTS.

THE D.P. BATTERY COMPANY, Ltd., of Bakewell, informs us that batteries of the D.P. "Kathanode" locomotive type are being fitted on six standard-gauge locomotives on order for the War Office and Air Ministry. The locomotives are being constructed by the English Electric Company, Ltd., Hawthorn, Leslie and Co., Ltd., and Joseph Booth Bros., Ltd.

WHAT is probably the largest contract of its kind ever placed has been signed by the Société des Phosphates Tunisiens, of Paris, with the International Electrolytic Plant Company, Limited, of Chester. It is for an installation of 600 standard Knowles Cells, each having a capacity of 7500 ampères. The installation is to produce by the electrolysis of water over 70,000 cubic feet of hydrogen and 35,000 cubic feet of oxygen per hour.

ED. BENNIS AND CO., Ltd., of 25, Victoria-street, Westminster, S.W. 1, have recently received orders from some thirty-six separate customers for a variety of their products, including a total of some forty-seven sprinkler stokers, four mechanical stokers, eight chain-grate stokers, two special forced draught stokers, two coal-handling plants, four ash-handling plants, two coal elevators, two truck tipplers, and one lime recovery plant.

HOWDEN-LJUNGSTROM PREHEATERS (LAND), Ltd., has received an order to supply one preheater to Brown and Adam, Ltd., of Pollokshaws, Glasgow. The total heating surface of the preheater is to be 26,000 square feet; and air will be supplied to the furnace at about 385 deg. Fah. The same firm has also received an order to supply one preheater to Thos. Chalmers and Sons, Ltd., Loch Paper Mill, Linlithgow. The total heating surface of this preheater is to be 6220 square feet; air will be supplied to the furnace at about 390 deg. Fah.

THE MIRRLEES WATSON COMPANY, Ltd., of Glasgow, has recently received, in face of severe competition, an order for a de-aerating and evaporating plant for the Ipswich Corporation electricity works. This de-aerator is to be capable of de-gasifying 150,000 lb. of feed water per hour and is to be supplied with steam from a Mirrlees feed make-up evaporator. The auxiliaries included in the order are as follows:—One hotwell pump, one de-aerator extraction pump, two Weir single-stage turbine-driven feed pumps, and one Mirrlees multi-stage motor-driven feed pump.

THE SHIPBUILDING TRADES' INVESTIGATION.—The fourth meeting of the joint committee of shipbuilding employers and the shipyard trades unions took place at Carlisle on Friday, May 29th. As on previous occasions, the proceedings were of a private nature. At the close of the meeting an official joint statement was made on behalf of both parties to the effect that a further meeting would be held in London to-day—Friday, June 5th.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	20/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	22/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 7 6	—
No. 1 Foundry	4 7 6	—
No. 3 Foundry	4 5 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 0 0	4 0 0
No. 1	4 0 6	4 0 6
Cleveland—		
No. 1	3 19 6	3 19 6
Silicious Iron	3 19 6	3 19 6
No. 3 G.M.B.	3 14 6	3 14 6
No. 4 Foundry	3 13 6	3 13 6
No. 4 Forge	3 12 6	3 12 6
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 7 6 to 3 9 0	
,, Forge	3 4 0 to 3 6 0	
(3) Derbyshire—		
No. 3 Foundry	3 12 6 to 3 15 0	
Forge	3 8 0 to 3 10 0	
(3) Lincolnshire—		
No. 3 Foundry	4 0 0	—
No. 4 Forge	3 15 0	—
Basic	3 15 0	—
(4) N.W. COAST— N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 13 0 (a); 4 16 0 (b); 5 1 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 12 6	—
Best ,,	—	—
N.E. COAST—		
Common Bars	11 12 6	—
LANCS.—		
Crown Bars	12 0 0	—
Second Quality Bars	11 10 0	—
Hoops	13 0 0	14 15 0
S. YORKS.—		
Crown Bars	13 0 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 12 6 to 12 15 0	
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 12 6 to 11 15 0	
Gas Tube Strip	13 0 0	—

STEEL.

	(6) Home. £ s. d	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	12 0 0	—
Ship Plates, ¾in. and up	8 15 0	—
Sections	8 5 0	—
Steel Sheets, under 3/16in. to ¾in.	10 5 0	—
Sheets (Gal. Cor. 24 B.G.)	—	17 5 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	—
Angles	8 7 6	—
Boiler Plates	13 0 0	—
Joists	8 7 6	—
Heavy Rails	8 15 0	—
Fish-plates	12 15 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 10 0	—
Soft Billets	8 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 15 0†	—
Light ,,	9 0 0 to 9 5 0	
Billets	8 0 0 to 11 0 0†	
MANCHESTER—		
Bars (Round)	9 0 0 to 10 0 0	
,, (others)	8 15 0 to 9 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	9 5 0	—
,, (Lancs. Boiler)	12 10 0	—
SHEFFIELD—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 0 0 to 9 5 0	
Intermediate Basic	8 0 0 to 8 15 0	
Soft Basic	7 15 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0 to 11 0 0	
MIDLANDS—		
Small Rolled Bars	8 15 0	—
Billets and Sheet-bars	6 17 6 to 7 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 10 0 to 16 15 0	
Angles	8 7 6 to 8 15 0	
Joists	8 7 6 to 8 15 0	
Tees	9 7 6 to 9 15 0	
Bridge and Tank Plates	9 5 0 to 9 10 0	
Boiler Plates	13 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/- to 20 6
Block Tin (cash)	252 10 0
,, (three months)	252 10 0
Copper (cash)	60 0 0
,, (three months)	61 0 0
Spanish Lead (cash)	32 15
,, (three months)	32 13 9
Spelter (cash)	35 0 0
,, (three months)	33 17 6
MANCHESTER—	
Copper, Best Selected Ingots	63 10 0
,, Electrolytic	64 10 0
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis price)	0 0 11½
,, Condenser	0 1 2
Lead, English	35 0 0
,, Foreign	33 15 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/8 to 1/9 per lb.	
Ferro Tungsten	1/5 to 1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/-
,, 6 p.c. to 8 p.c. ,,	£23 5 0	7/9
,, 8 p.c. to 10 p.c. ,,	£23 0 0	7/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£43 0 0	15/6
,, ,, 1 p.c. ,,	£52 0 0	17/-
,, ,, 0.70 p.c. carbon	£57 10 0	19/-
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 15 0	scale 5/- per unit
,, ,, 75 p.c.	£22 10 0	scale 6/- per unit
,, Vanadium	17/- per lb	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/- per lb	
Nickel (per ton)	£175	
Cobalt	10/3 per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/9
,, ,, Ell	15/-
,, ,, Splint	15/9 to 18/-
,, ,, Trebles	14/6
,, ,, Doubles	13/9
,, ,, Singles	12/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/9
,, ,, Splints	16/-
,, ,, Trebles	14/3
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	13/6 to 15/4
Screened Navigation	21/6
Trebles	14/6 to 15/-
Doubles	12/6
Singles	12/3
LOTHIANS—	
(f.o.b. Leith)—Best Steam	15/6
Secondary Steam	14/9
Trebles	15/6
Doubles	13/3
Singles	12/6

ENGLAND.

	Inland.	Export.
(8) N.W. COAST—		
Steams		20/-
Household		45/- to 58/4
Coke		28/-
NORTHUMBERLAND—		
Best Steams		16/6 to 17/-
Second Steams		16/3 to 16/6
Steam Smalls		10/6 to 11/9
Unscreened		15/6 to 16/6
Household		23/6 to 25/-
DURHAM—		
Best Gas		18/9 to 19/-
Second		16/6 to 17/-
Household		23/6 to 25/-
Foundry Coke		20/- to 22/6
SHEFFIELD—		
Best Hand-picked Branch	30/- to 33/-	—
Barnsley Best Silkstone	26/- to 27/-	—
Derbyshire Best Brights	26/- to 28/6	—
,, ,, House	23/6 to 25/6	—
,, ,, Large Nuts	18/- to 22/-	—
,, ,, Small	14/- to 16/-	—
Yorkshire Hards	18/- to 22/-	—
Derbyshire ,,	18/6 to 22/-	—
Rough Slacks	10/- to 12/6	—
Nutty ,,	8/6 to 10/-	—
Smalls	3/- to 5/6	—
Blast-furnace Coke (Inland)*	—	—
,, ,, (Export)	f.o.b.	21/3 to 22/3

CARDIFF— (9) SOUTH WALES.

Steam Coals:	
Best Smokeless Large	26/- to 26/6
Second ,,	25/- to 26/-
Best Dry Large	25/- to 25/6
Ordinary Dry Large	23/6 to 24/6
Best Black Vein Large	24/6 to 25/-
Western Valley ,,	23/6 to 24/6
Best Eastern Valley Large	23/- to 24/-
Ordinary ,, ,,	22/6 to 23/-
Best Steam Smalls	15/- to 15/9
Ordinary ,,	13/- to 15/-
Washed Nuts	20/- to 27/6
No. 3 Rhondda Large	26/6 to 27/-
,, ,, Smalls	17/- to 17/6
No. 2 ,, Large	22/- to 23/-
,, ,, Through	18/- to 20/-
,, ,, Smalls	12/- to 13/6
Foundry Coke (export)	40/- to 47/6
Furnace Coke (export)	25/- to 30/-
Patent Fuel	22/- to 26/-
Pitwood (ex ship)	24/- to 24/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	44/- to 46/-
Seconds	38/- to 40/-
Red Vein	30/- to 32/6
Machine-made Cobbles	52/6 to 55/-
Nuts	50/- to 55/-
Beans	37/6 to 40/-
Peas	21/6 to 23/6
Breaker Duff	8/- to 8/3
Rubbly Culm	11/- to 13/6
Steam Coals:	
Large	23/6 to 25/-
Seconds	21/- to 22/-
Smalls	10/- to 13/-
Cargo Through	16/- to 19/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/6, with fluctuations according to analysis; open market, 18/- to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Iron and Steel.

MILL and forge owners have to rely so entirely upon an export demand for the disposal of a heavy surplus production that the considerable restriction of foreign buying is causing them serious embarrassment. The home consumption has been falling off for some time past, and while most branches of the engineering trades are taking less metal, other buyers are limiting purchases in the belief that the present high prices are not justified by the situation, although it is evident that makers have the firm intention of strengthening their combination to maintain them. It is only by keeping up prices on the home market that they can hope to dispose of iron and steel abroad. Nevertheless, foreign buying is very slow, despite the continuous depreciation of the franc, and the fact that the offer of specially attractive terms fails to stimulate export trade is one of the most unsatisfactory features of the situation, implying, as it does, a lessening activity in all the foreign markets. Producers have always relied upon the difference in money values to encourage speculative buying, but this is now at an end, and the outlook is giving rise to serious concern. The immediate effect must be to accentuate the competition for foreign business.

Hydro-Electric Distribution.

Many complaints have been made that the cost of electricity has not been brought down to anything like the level that was anticipated by the promoters of the national electrification scheme, who held out the promise that with the utilisation of water power it would be possible to distribute current cheaply all over the country. Especially was the promise attractive to the farming community, which was to enjoy preferential treatment over industrial users, and it was stated that rural districts would be electrified under conditions that would solve the pressing problems of power and labour. A considerable amount of electrification has taken place in rural districts, but it is far from economical, because the distributing companies are unable to get the price down low enough. They cannot charge industrial users a price that will allow of their offering preferential terms to agriculturists. It is found that the cost of distribution increases in rapid ratio with the distance, until the power user finds that it is more economical to employ coal. There is consequently something like a crisis in hydro-electric distribution. The original programme provided for the distribution of 4,500,000 kilowatts, of which 1,200,000 kilowatts were to be supplied by the Rhine and the Rhone. Since 1919 the rate of progress has been very slow, and in 1924 the total amounted to 2,300,000 kilowatts, including the works carried out by the State during the war and immediately after the Armistice. The work on several hydro-electric installations has been suspended or stopped altogether because it is impossible to obtain capital for a class of undertaking that does not offer sufficient promise of an adequate return. Efforts have been made to attract industrial activity to the centres of water power production, but they have in all cases failed, and the only hope of carrying out the scheme of electrification now lies in a complete organisation of electrical supply under conditions which will bring down the price to the consumer. A committee was appointed some time ago to work out the details of a programme which aimed at rendering all the different sources of supply interdependent so that they would come to each other's relief in case of necessity. Thus the hydro-electric plants of the Alps and the Rhone will be connected up with the heat-generating stations in the north of France, and no further concessions will be granted unless they fall in with the general scheme of organisation. This will insure a regularity of supply, but it is not quite clear how it will bring down the cost of current appreciably. For the moment the electrification scheme has only made a marked advance in the case of the railways. Industrial users do not find that electricity is an economical form of energy.

Textile Industries.

The reconstruction of the textile factories in the Nord has increased the production so far beyond home requirements that the industry can only look for future prosperity to the foreign trade. As many consuming countries are putting up further barriers against imported textiles, the situation of French firms has become precarious, and for several months past there has been a serious crisis in the Roubaix district, where manufacturers are unable to dispose of their goods. Representatives of some of the firms have therefore been visiting North Italy with a view of seeing whether it would be to their interest to transfer a part of their plants to that country. This move has created strong feeling in France, where the Government has been invited to make a true statement of the situation. It is difficult to see what can be said beyond the fact that some French industries have developed so considerably during the past five or six years that they must dispose of a surplus production in foreign markets and competition in those markets is becoming increasingly keen.

Paris Metropolitan.

The Paris Metropolitan Railway is to be further extended with the aid of the 500 million franc loan which has been sanctioned by the Senate. When the two new sections are completed, the length of the railway will be 123 kiloms., and there will still remain 31 kiloms. to be constructed to complete the system. The programme will then comprise an extension of the railway to the suburbs, the first operation being the taking over the line at the Bastille. The idea is that, in time, all the suburban lines will be incorporated into the Metropolitan system, but in some cases that will present considerable difficulty, notably in that of the State electrified line between Saint-Lazare and Auteuil, which is in competition with the Metropolitan and is being run at a heavy loss. The working results of the Metropolitan are financially satisfactory, for with an improvement in the electrical equipment, the cost of current has been cheapened, and the traffic receipts are rapidly increasing, the amount for 1924 being 194,585,781 francs, as against 160,936,133 francs in the previous year.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

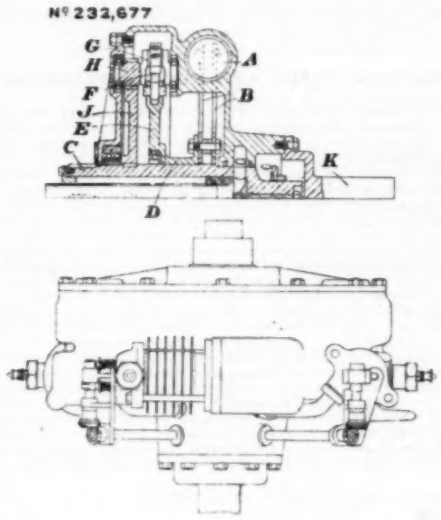
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

232,677. January 22nd, 1924.—ROTARY ENGINES, A. J. Yeo, 118, Robert-street, Plumstead, S.E. 18.

In this engine the pistons A are arranged to operate in the tangential cylinders in the usual manner, but the big ends of the connecting rods are attached to the outer ends of arms B having a free wheel connection with the main shaft C. Secured to the arms B is a hub D carrying two oppositely extending radial arms E, to the outer end of each of which is connected a control arm F. The outer ends of the control arms are mounted on crank pins G carried by a planet pinion wheel H journalled in the casing and gearing with a sun wheel J fixed to the main shaft. Secured to the outer face of the casing is a driving shaft K. With the above arrangement it will be seen that when an explo-

Nº 232,677

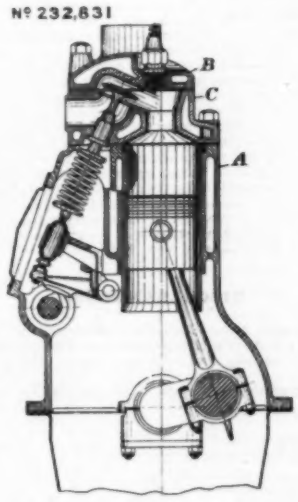


sion occurs in any of the cylinders the impulse reacts against the piston, and as the piston is held from rotating in a backward direction by the arms B the cylinders are caused to rotate in a forward direction carrying with them the casing on which they are mounted and the planetary pinions H. During this movement, however, the crank pins G travel in a backward direction, which permits the return arms E and the arms B to remain stationary so that the cylinders move away from the pistons until the pistons have reached the end of the stroke, after which the continued movement of the cylinders and the planet pinions causes the crank pins G to draw the arms B after the cylinders and return the pistons, thus effecting the return stroke of the pistons.—*April 22nd*, 1925.

232,831. July 30th, 1924.—COMBUSTION CHAMBERS, *E. C. R. Marks, 57 and 58, Lincoln's Inn-fields, London, W.C. 2.*

The aim of this invention is to reduce the weight of the engine, and for this reason the cylinder body A and its cover B are of an

Nº 232,831



aluminium alloy, while the combustion chamber C and the cylinder liner are of cast iron. The combustion chamber is formed with a narrow neck, as shown, to create turbulence in the charge, and the valves are set at a considerable angle to the cylinder axis.—*April 30th*, 1925.

DYNAMOS AND MOTORS.

223,556. October 8th, 1924.—COMPENSATED ALTERNATING-CURRENT MOTOR FOR SINGLE OR POLYPHASE CURRENT WITH DIFFERENT BRUSH POSITIONS FOR CLOCKWISE OR ANTI-CLOCKWISE ROTATION, Deutsche Werke, Aktiengesellschaft, of 90, Westfälische Strasse, Berlin-Wilmersdorf, Germany.

In altering the direction of rotation of compensated alternating-current motors for single or polyphase current with different brush positions for clockwise or anti-clockwise running it is of great importance that upon each change of direction the brushes are brought into the position whereby the machine works without internal power loss. Compensated motors with brushes in an incorrect position absorb more power internally than uncompensated motors, and the object of their use is defeated. The object of this invention is to provide a simple means whereby a correct positioning of the brushes may be assured.

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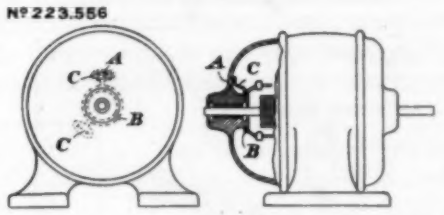

The motor casing is provided with an aperture A upon the side on which the brushes are situated, whilst the brush holder B has two extensions C. Upon the latter are direction marks which indicate ot the sense of rotation of the motor. The spacing of the two direction marks from one another corresponds to the brush displacement angle. The position of the brush holder for a given sense of rotation of the motor is correct when the direction mark of that sense appears in registration with the aperture.—*April 30th*, 1925.

232,758. April 1st, 1924.—IMPROVEMENTS IN AND RELATING TO DYNAMO-ELECTRIC MACHINES, Charles Anthony Vandervell, of 29, Holland Park, W., and C. A. Vandervell and Co., Ltd., of Warple Way, Acton, W. 3.

This invention relates to the manufacture of magnet yokes for dynamo-electric machines and more particularly for the smaller types of machines, such as used for lighting on motor cars and for starting purposes. Hitherto magnet yokes have usually been made of castings or steel tubes, which had to be turned with great accuracy to the desired internal diameter, a process which involved a substantial amount of work. The main object of the invention is to produce magnet yokes for dynamo-electric machines in a greatly simplified way, thereby substantially reducing the cost of manufacture. Another object is that the accuracy of the yoke as regards its internal diameter shall be as perfect as possible. The invention consists in making the yoke of two or more sleeves fitting into one another and pressed together in a pressing machine, such as a hydraulic or similar press, so as to unite them into one single body. In this way a yoke of the desired thick-

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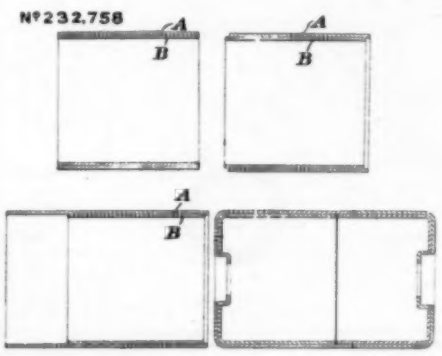


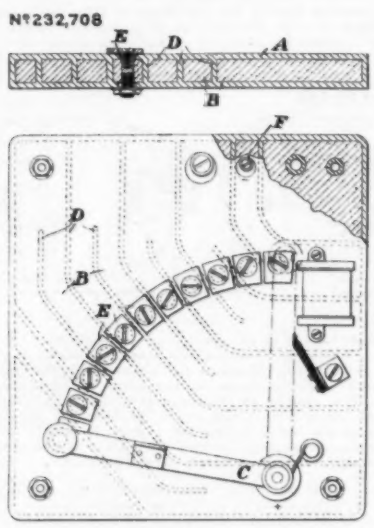
nees and of great accuracy is obtained without any turning whatsoever being required. A and B are two sleeves united by pressure into a single body forming a magnet yoke. In the top right-hand illustration the two sleeves are fitted into one another before they are pressed together in such a manner that A overlaps B at one end and B overlaps A at the other end, so that after they have been pressed together spigots will be formed at both ends, without any turning being necessary, it being understood that either the internal sleeve may overlap the outer sleeve or *vice versâ* at one end only. In the lower left-hand illustration one of the sleeves, preferably the outer one A, is extended on the commutator side of the machine, such extension forming a carrier for the brush gear, and a cover. According to a modification of the invention, the sleeves are formed with end pieces so as to constitute two or more cup-shaped members, such cup-shaped members, which fit into one another and are pressed together as above described, having their end pieces adapted to form end shields or housings for the ball bearings. The latter form of construction is illustrated in the lower right-hand drawing, in which two pairs of cup-shaped members are used.—*April 30th*, 1925.

SWITCHGEAR.

232,708. January 31st, 1924.—IMPROVEMENTS IN AND RELATING TO STARTERS FOR ELECTRIC MOTORS, The Morgan Crucible Company, Ltd., and Colin Clarence Gow, both of Battersea Works, Church-road, London, S.W. 11.

According to this invention a starter for electric motors comprises a panel of non-conducting ceramic material with which is incorporated a resistance composed of non-conducting ceramic material admixed with carbon encased in the non-conducting ceramic material of the panel with which it forms a continuous coherent body. A is the face-plate and B the resistance which are incorporated to form a single panel or unit. The body of the panel is composed of ceramic material and the resistance is also formed of the same or similar material, but having incorporated with it flake graphite or other powdered carbon. The resistance B follows a zig-zag or circuitous path. The ceramic material, of which the panel is composed, may be made of a plastic insulating clay composed of 40 per cent. ball clay and 60 per cent. burnt clay grog free from iron and impurities. The resistance may be composed of the same materials and plumbago in the proportion of 40 per cent. clay, 40 per cent. clay grog, and 20 per cent. plumbago. The graphite is added to the clay whilst the latter is in a plastic state, and a layer of the mixture, such as indicated at B, is applied to a layer of the insulating clay, and grooves, as indicated at D, are cut completely through it to form a circuitous or zig-zag resistance. These grooves are filled with plastic insulating clay and the layer finally coated completely with the clay. The panel thus made is then burnt and, if desired, glazed on the exterior, after which the fittings and accessories are applied. C is the starting handle of usual construction, and E are the contact studs with which the handle C is designed to make contact. These studs are in good electrical contact with the graphite resistance B at different points along its circuitous course, so that, as the handle is moved from the position shown, the path

of the current from the handle to the negative terminal F will be gradually shortened, and consequently the resistance offered to the current by the material B will be lessened until the han-

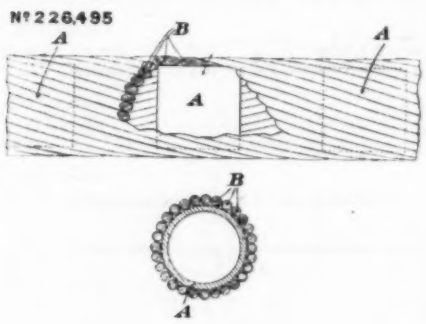


dle rests on the last of the series of studs E as indicated by the dotted lines, when the whole of the resistance is cut out.—*April 30th*, 1925.

TRANSMISSION OF POWER.

226,495. September 24th, 1924.—ELECTRIC CABLE, Société Electro-Cable, 2, Rue de Penthièvre, Paris.

The cable constructed according to this invention comprises a core which consists of a number of rings A spaced apart. The core thus formed serves as a support for a layer of conducting

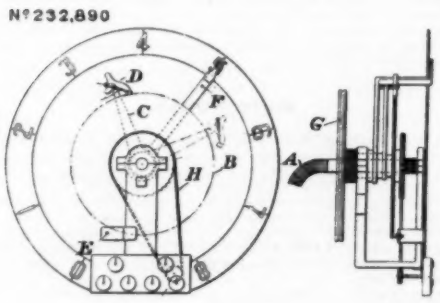


wire B. The wires are placed in contact and are wound upon the core in helices of large pitch. Obviously, instead of placing only a single layer of conducting wire upon the core as shown, a number of superposed layers may be employed. A filling of a suitable substance, such as hemp, may be placed in the interior of the core.—*April 30th*, 1925.

MEASURING AND TESTING INSTRUMENTS.

232,890. December 29th, 1924.—INTEGRATING MECHANISM FOR METERS, B. Dunglingson, 109, Kingsway, London, W.C. 2.

This device is intended for use in conjunction with chain-grate stokers for giving a record of the amount of coal consumed. The flexible shaft A is driven by one of the drums of the chain-grate and rotates the ratchet wheel B by means of the arm C and pawl D. The pawl is controlled by a spring and is put in engagement

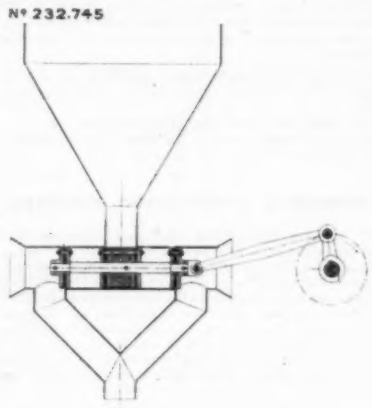


with its wheel by means of a fixed stop E, while a movable stop F disengages it. The movable stop is on an arm which is connected with the wheel G and round this wheel there runs a chain connected with the gate of the stoker. The ratchet wheel drives a counting mechanism through the chain H. It will be seen that the indication of the counter will be dependent on the position of the movable stop and consequently on the thickness of the fire, and also on the speed of the grate.—*April 30th*, 1925.

CRANES AND CONVEYORS.

232,745. March 17th, 1924.—GRAIN HANDLING PLANT, G. F. Zimmer, 82, Mark-lane, London, E.C. 3.

This device is intended for discharging the grain from the hoppers of pneumatic grain elevators without the admission of air, which would destroy the vacuum in the hopper. It comprises a compound piston which is reciprocated in a cylindrical chamber beneath the hopper. The several sections of the piston are so assembled on a rod as to provide two spaces, on either side of the central piston, which are alternately filled with grain from

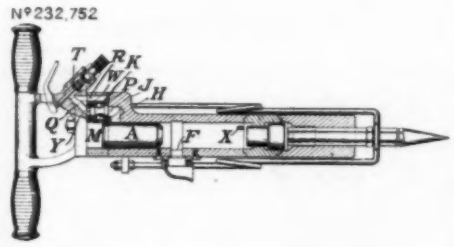


the hopper above and are discharged into the branches of the outlet pipe below, as the piston is reciprocated. Air-tightness is ensured by means of cup leathers.—*April 30th*, 1925.

MACHINE TOOLS AND SHOP APPLIANCES.

232,752. March 24th, 1925.—PNEUMATIC HAMMERS, The Howard Pneumatic Engineering Company, Ltd., 25, Victoria-street, London, S.W. 1, and P. C. Bird, 3, Willington-road, Eastbourne.

The inventor of this tool has aimed at a specially effective cushioning of the hammer on the return stroke, so that it cannot strike the handle, even when it is worked in an upward direction. Apart from the fact that the port X is in communication with the valve chamber K, by means of a longitudinal passage not shown, the action of the tool can be readily followed in the drawing. Assuming the piston A to be at the forward end of its stroke, when the main air valve T is opened air enters both branches of the bifurcated passage Q R, the pressure in the branch Q acting on the smaller end of the differential control valve M, driving it forward, thus closing the air supply ports P by which the branch R is adapted to communicate with the valve chamber K, and opening, to the branch Q, the circumferential series of ports W through which communication between the valve chamber K and the forward end of the cylinder is thus established. Air passes to the forward end of the cylinder, drives back the piston A, and after the latter has passed the exhaust port F air is compressed in the back end of the cylinder and in the passage J. Just when this port H is covered by the piston A, the pressure in the passage

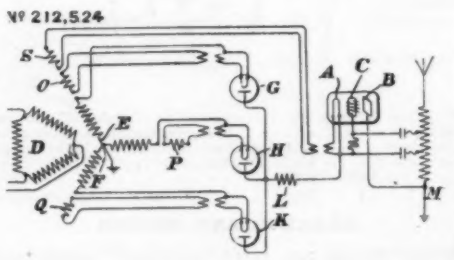


J acting on the larger end of the differential valve drives it back, thus opening the air supply ports P leading from the valve chamber to the passage J, closing the ports W through which the air supply reaches the forward end of the cylinder, and uncovering the circumferential series of ports Y through which, and the longitudinal passage (not shown) and the recessed intermediate peripheral portion of the valve M, the forward end of the cylinder is then put into communication with the atmosphere. At the same time as the control valve M is being reversed, the piston A continues its backward movement, during which it raises to a pressure higher than that of the air supply the air trapped in the back end of the cylinder, the air inlet H and the differential valve being completely isolated from the sealed chamber in which the air is trapped. This high pressure trapped air serves to give the piston a good start on its next stroke. Owing to the fact that the port H is already in communication with the air supply, air at full pressure is admitted to the cylinder as soon as that port is uncovered by the piston during its forward stroke, consequently "wire drawing" is considerably reduced or eliminated. When, during its forward stroke, the piston uncovers the exhaust port F, the differential control valve M is reversed and the cycle of operations repeated.—*April 30th*, 1925.

MISCELLANEOUS.

212,524. January 26th, 1924.—IMPROVEMENTS IN RECTIFYING SYSTEMS FOR ALTERNATING CURRENTS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.* 2.

One object of this invention is to provide an arrangement



which will permit of the operation of the anodes of the electron discharge consumption devices at earth potential when these devices are supplied with direct current by a rectifying system in which individual rectifiers are provided for each phase of the alternating current and the cathodes of the individual rectifiers are connected to points in the secondary winding of the transformer which are normally at different potentials, the anodes of the rectifiers being all connected together and to one side of the consumption circuit, whilst a neutral point in the secondary winding of the transformer is connected to the other side of the consumption circuit. A system is illustrated for supplying direct current for the operation of an alternating-current generator of the thermionic type consisting of the usual thermionic cathode A, anode B, and discharge controlling member C. Current for the operation of this device is derived from an alternating current source comprising a three-phase transformer having a delta connected primary D and a Y-connected secondary E. The neutral point F in the secondary winding may be earthed and the high-tension terminals connected to the cathodes of individual thermionic rectifiers G, H, and K. The anodes of these rectifiers are all connected together and connected through a combination radio frequency choke and smoothing inductance L to the cathode A of the generating device. This device is arranged to produce oscillations in the antenna in the well-known manner and the anode B is connected at M to the earth connection of the antenna. The anode B being at earth potential it is possible to use water cooling of the anode without insulating the apparatus by means of which the cooling water is supplied. Since the anodes of rectifiers are all at the same potential, a common cooling system may be provided for cooling the anodes of all of the rectifiers. Individual transformer windings O, P, and Q may be provided for supplying heating current to the cathodes of the rectifiers. These transformer windings may be combined with the high-tension bushing of the transformer terminal and the insulation thereof is therefore simplified. An additional secondary winding S may also be provided for supplying heating current to the cathode A of the consumption device.—*April 27th*, 1925.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

THURSDAY TO SATURDAY, JUNE 4TH TO 6TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Scottish District Meeting at Dumfries.

TO-DAY.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse, "The Tomb of Tut-ankh-amen," by Mr. Howard Carter. 9 p.m.

SATURDAY, JUNE 6TH.

INSTITUTION OF ENGINEERS-IN-CHARGE.—Visit to Bushey House, Teddington. 2.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Southern District meeting at Reading. 11 a.m.

THE INSTITUTION OF AERONAUTICAL ENGINEERS.—Visit to the Croydon Aerodrome. 3 p.m.

MONDAY, JUNE 8TH.

FARADAY SOCIETY.—Institution of Civil Engineers, Great George-street, London, S.W. 1. Joint meeting with the Iron and Steel Institute. Symposium and discussion on "The Physical Chemistry of Steel Making Processes." 3.30 p.m.

ROYAL INSTITUTION.—21, Albemarle-street, London, W. 1. General meeting of members. 5 p.m.

TUESDAY TO FRIDAY, JUNE 9TH TO 12TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Summer meeting at Birmingham and District. For programme, see page 380.

INSTITUTION OF GAS ENGINEERS.—Annual general meeting in London. For programme, see page 414.

FRIDAY, JUNE 12TH.

ROYAL INSTITUTION.—21, Albemarle-street, London, W. 1. Discourse, "Faraday as a Chemist," by Sir William Pope. 9 p.m.

TUESDAY TO THURSDAY, JUNE 16TH TO 18TH.

INSTITUTION OF MINING ENGINEERS.—Eighty-third general meeting at Cardiff. For programme see page 608.

WEDNESDAY, JUNE 17TH.

INSTITUTION OF CIVIL ENGINEERS.—The Institution's Building, Great George-street, Westminster, S.W. 1. Conversazione. 8 p.m.

THURSDAY TO SATURDAY, JUNE 18TH TO 20TH.

NEWCOMEN SOCIETY.—Summer meeting at Gloucester.

SATURDAY, JUNE 20TH.

THE INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Visit to the works of Ley's Malleable Castings Company, Limited, Derby. 2.30 p.m. The party will leave Manchester (Central) at 12.20 p.m.

LAUNCHES AND TRIAL TRIPS.

NAIRNBANK, twin-screw motor vessel; built by Harland and Wolff, Ltd., to the order of Andrew Weir and Co., Ltd.; dimensions, 434ft. by 53ft. 9in. by 37ft.; 5200 gross tonnage. Engines, two sets of Harland-B. and W. motors; constructed by the builders; launch, May 21st.

PRINCESS MARIE JOSE, single-screw steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of L. Dens and Co.; dimensions, 315ft. by 45ft. by 22ft. 10in. Engines, inverted, direct-acting, triple-expansion; constructed by the Wallsend Slipway and Engineering Company, Ltd.; launch, May 25th.

INVERRUBA, twin-screw oil vessel; built by Harland and Wolff, Ltd., to the order of Andrew Weir and Co., for the Lago Shipping Company, Ltd.; dimensions, 315ft. by 50ft. broad; 2360 gross tonnage. Engines, twin-screw, triple-expansion, pressure 180 lb.; constructed by the builders; launch, May 26th.